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NATIONAL NUTRITION AND BRITISH AGRICULTURE[1]

I—AGRICULTURE AND PUBLIC HEALTH

Sir John Orr, D.S.O., M.C., M.A., M.D., M.Sc., F.R.S.

Five years ago, if a paper on human diet had appeared on the programme of the Agricultural Section of the British Association, it would have been regarded as a printer's error. The members would have thought that one of the papers of the Physiology (the Medical) Section had got into the Agricultural Section by mistake. But much has happened in the last few years to warrant agricultural chemists studying food requirements and also to warrant those interested in public health studying agricultural economics.

Let us consider what is happening in agriculture. The last few years have been a period of experimentation and change in the national agricultural and economic structure. The old order of *laissez-faire* and drift is passing away. A serious effort is being made to put agriculture in the stable position in which it should be in the interests not only of farmers, but of the whole nation. We are in the throes of the birth of a new national agricultural policy. What the policy will ultimately become is not yet clear in all its details, but it is already evident that it will be on a much broader basis than merely protecting the economic interests of farmers.

A change in our agricultural economic system, which was bound to come in any case, was precipitated by the world economic crisis. Agricultural prices fell to such a low level that the industry was threatened with collapse. A number of different measures were taken to meet the situation. The kind of measures applied to the different branches of agriculture varied according to the needs of the case. For some products protection in the form of import duties was given. Other products received a direct subsidy. In some cases, marketing schemes which give producers control of the markets were tried. In other cases a quota was applied to imports to prevent the flooding of the market by the dumping of subsidised exports from other countries. We proceeded by the process of trial and error, applying whatever measure appeared most likely to meet the immediate difficulties.

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[1] The four papers included under this heading were read before Section M of the British Association at Blackpool, September 1936.

With so many different measures our agricultural economic structure now looks rather a patchwork affair. And indeed the patches are not very even. Some branches have been strengthened out of all proportion to others. In Scotland the view is held that the subsidy for wheat, with no corresponding subsidy for oats, is probably the most glaring example of uneven treatment due to hasty piecemeal legislation. The criticism has been offered that the Government has no plan and no guiding principle; that it is merely dealing with pressing difficulties as they arise. To some extent this critcism is justified. As a matter of fact, however, it was wiser to deal with difficulties as they arose in accordance with the realities of the case than to begin in a period of world economic crisis to reorganise agriculture according to some new and untried scheme. A permanent agricultural policy applied in the crisis of 1930 in the narrow interests of agriculture might not only have been harmful to the country but in addition might ultimately have proved to be harmful to the industry itself.

Judged by results, the empirical policy pursued in the last five years has on the whole been successful. The additional money which the various measures adopted have brought into the industry, combined with the increased purchasing power of the consumer which has accompanied the improvement in trade, has enabled agriculture to weather the storm. The immediate danger of a collapse has been averted. The position is much better than it was five years ago. We have gained a breathing-space in which we can review the position in the light of our experience of the last five hectic years and begin to work towards, not a permanent policy, for no policy can be permanent in this rapidly changing world, but a more comprehensive policy which will meet all the interests of the community as well as those of agriculture.

Agriculture is concerned with the production of food. Let us consider now the equally important aspect—consumption. In pre-war days it was generally assumed that if any person had food to eat sufficient to satisfy hunger, his needs would be met. In other words, if the quantity of food were sufficient, there was no need to trouble about the quality. But in the last twenty-five years there has arisen a new science of nutrition which has revolutionised our ideas about the effect of food on health. The discoveries of this new science have shown that health and physique are largely dependent on the kind of food eaten. We now know that a diet to be adequate for health must contain a sufficient amount of vitamins, constituents of food whose existence was previously unknown, and also sufficient amounts of a number of mineral salts, whose importance for health was not previously recognised. Hence, we now estimate food requirements not so much according to the amount required to satisfy appetite, but rather according to the amount of these constituents required to maintain health. The agricultural products richest in these health factors are milk, dairy products, eggs, fruit and vegetables. These have been called the "protective" foods because they are rich in the health factors that protect against disease.

Last year the Assembly of the League of Nations appointed a committee of physiologists with representatives from the chief countries in Europe, the British Empire and the United States, to draw up a general statement of the kind of diet which would contain a sufficient amount of all the food constituents needed to maintain optimum health. The committee drew up a statement of the kinds of diet needed for pregnant and nursing mothers, and for children of different ages. These are the members of the community who need the best diet. It is among mothers and children that poor physique and ill health due to faulty diet is most prevalent. A diet good enough for mothers and children will more than meet the requirements of others.

The report which has been published is too long to quote in detail. As an example of the kind of diet adequate for health, we may take that recommended for a child of 3 to 5 years of age. This should include 1 litre (1⅜ pint) of milk, one egg, 1 oz. meat, fish or liver, 5 oz. potatoes, and ¼ lb. of green leafy vegetables or fruit. These amounts of the "protective" foods make up roughly two-thirds of the total amount of daily food needed as measured in energy values. The remaining third should be made up mainly from butter and cereals. In addition to these protective foods it is recommended that about a teaspoonful of cod-liver oil should be given daily. This is an important safeguard under bad housing conditions, especially in winter, when little sunshine is available.

It should be noted that the dietary schedule drawn up by this committee gives merely an example of the kind of diet that will contain everything required for health. What the committee did was to take the food-stuffs in common use in Europe and America, and draw up a diet which would meet the requirements of the average individual and which would therefore serve as a standard, and a guide in practice. Hundreds of different diets containing all that is needed could, of course, be drawn up with the food-stuffs in slightly different proportion, or indeed with other food-stuffs not mentioned in these schedules. All the diets adequate for health, however, that could be drawn up would contain the same high proportion of the "protective" foods.

Unfortunately, the "protective" foods—*i.e.* those rich in vitamins and minerals and animal protein: *e.g.* milk, dairy products, eggs, fruit and vegetables—are relatively expensive. At present prices, the above diet recommended for a child of 3 to 5 years would cost between 5s. and 6s. a week, and that recommended for a pregnant and nursing mother would cost about 9s.

It is not to be wondered at, therefore, that when the kinds of diet in common use in different classes are compared with this standard, it is found that the diets of the poorer classes fall below it. In a preliminary survey it has been found that the diet of the poorer half of the population is below the standard and that it gets worse as family income falls, the worst diets being in the households of poorly-paid workmen with large families.

There has recently been a good deal of discussion as to the extent to which the bad diet of the poorer section of the community is due to ignorance or poverty. Ignorance on food values is common in all classes, but there is no evidence to suggest that the housewife in the poor families knows less about the health value of foods than her wealthier sister; indeed, all the available evidence suggests the contrary. This question can be settled by an enquiry. The money available for food at lower income levels can be estimated, and the cost of a diet adequate for health can be determined. From these results it is possible to estimate the number of families who are too poor to purchase a diet according to modern health standards.

There is some difference of opinion as to the proportion of the total population too poor to purchase a diet on the standard recommended. There is agreement, however, that among the poorer-paid working classes there are many households, the income of which is insufficient to meet the necessary expenditure on food. The greatest difficulty is in the case of milk. The Advisory Committee on Nutrition set up by the Government has recommended that pregnant and nursing women should have, for health reasons, two pints of milk per day, and a growing child about a pint and a half. Hence, in a family with a pregnant or nursing mother and four children, the cost of milk at 2s. per gallon would be 14s. per week. This is undoubtedly beyond the purchasing power of a considerable section of the community. Our Public Health measures which supply free or cheap meals and milk at reduced prices to mother and children deal with the worst effect of this poverty.

An enquiry done recently showed that the consumption of " protective " foods falls as family income falls, and is therefore lowest amongst the poorest. To what extent would consumption of these increase if purchasing power were raised or if retail prices were reduced? An experiment to test this was carried out by the Potato Marketing Board. In Bishop Auckland, which is in a depressed area with a large number of unemployed, potatoes were made available on the " cash and carry " principle for 4d. per stone instead of the ordinary retail price of 7d. at the shops. It was found that the consumption of potatoes increased by 69 per cent. This result falls in line with observations on all other food-stuffs. As the retail price decreases, consumption increases.

When we compare the health and physique of different classes of the community, we find that there is a correspondence between these and the kind of food eaten. The children of the poorest classes grow more slowly than the children of the well-to-do. The incidence of diseases known to be due to faulty diet, such as rickets, is more prevalent among the poor. A good indication of the physical fitness of any group of people is the infant mortality rate. This is more than twice as high amongst the poor as it is amongst the well-to-do.

Where tests have been carried out to test the effect on health of improving the diet, it has been found that as the diet of the poor is made more like that of the rich, the children grow faster and diseases due to faulty diet decrease. There has been a remarkable improvement in the average diet of the whole nation since pre-war days owing to increased consumption of " protective " foods. The consumption of fruit has increased by over 80 per cent, that of vegetables by about 60 per cent, and that of eggs and dairy products by, roughly, about 50 per cent. Accompanying that improvement in the national dietary there has been a corresponding improvement in the health and physique. Children of about 14 or 15 are now from one to two inches taller, the incidence of diseases such as rickets due to faulty diet has gradually decreased, and infant mortality rate has fallen in England from over 100 to 57 per thousand. All the indications are that if the diet of the poorer half of the population were brought up to the level recommended by the committee appointed by the League of Nations, there would be a remarkable improvement in health and physique and a great reduction in disease. But if everyone is to have this diet, the average consumption of milk of the whole population would need to be doubled, and there would also need to be a substantial increase in the consumption of dairy products, eggs, fruit and vegetables. There is not sufficient of these food-stuffs in the country at the present time to meet the health requirements of the whole population. From the health point of view, therefore, there is need for a great expansion of agriculture in this country, especially in animal products, fruit and vegetables. These constitute between 70 and 80 per cent of the total agricultural output.

But the consumption of these protective foods is limited by the retail price, and if consumption is to be increased, the retail price must be reduced. This brings us up against the real problem of agriculture. In the interest of public health, the production of " protective " foods must be increased and the retail price must be reduced. On the other hand, in the interest of the producer the price he gets must be increased. The industry has for many years been living on its capital. The buildings and equipment on most farms need to be brought up to date if the industry is to be efficient, and there is no money in the industry to do this. The wages and the general standard of living of farm workers are lower than those of workers of equal skill in industry, and the profits in the industry are not sufficient to enable wages to be brought up to the level at which everyone recognises they should be.

To enable the whole population to get a diet fully adequate for health, the purchasing power of the poor must be increased, or the retail price of food must be reduced. At the same time the producer must get a remunerative price which must be high enough to enable him to pay increased wages to the agricultural labourers and to modernise his equipment. There is thus an apparent conflict between the interest of the consumer and the interest of the producer. It is impossible to subsidise public health off agriculture. It is equally impossible to subsidise agriculture at the expense of the poorer half of the population. For this reason an agricultural policy designed without reference to the needs of the community for food is difficult, and indeed impossible, and a public health policy which does not make provision for increased production of animal products, fruit and vegetables, and for making them available at a price within the reach of the poorest, is impossible. Both agriculture and public health must be looked at together as part of the one great food problem. Both the health and agricultural problems can be solved provided the State is willing to embark upon a national food policy. This will cost money, but there is no object on which the State could better expend money than on promoting a prosperous rural industry and building up the health and physique of the rising population.

II—A NATIONAL PLAN FOR AGRICULTURE

Sir Daniel Hall, K.C.B., F.R.S.

Following upon the original Marketing Act introduced by Dr Addison, the present Government has placed upon the Statute Book further measures which may be the basis of a complete reconstruction of British agriculture. The Marketing Acts confer upon appointed bodies, ultimately upon the Ministers responsible for Agriculture, control over the sale, distribution and processing, and by implication the *production* for sale of all commodities of an agricultural or horticultural nature. At present these powers are only being partially exercised and affect only a few products—milk, potatoes, pigs and bacon and hops. Again each Marketing Board is independent and works upon no co-ordinated system.

Meantime the State has committed itself to large expenditure for the improvement of the agricultural situation, by way of direct subsidy, levies, duty and the remission of taxation. In his Presidential Address to Section M in 1935, Dr Venn estimated the assistance then being given to agriculture, both from the Exchequer and from consumers, as amounting to about £40 millions a year; some addition has since been made to the cattle subsidy.

On the other side of the account may be reckoned the increased rate of wages which farmers have been compelled to pay since the restoration of the Agricultural Wages Act in 1924. It is difficult to estimate what the effect of this measure has been, because in many districts wages never fell below the old statutory minimum of 30s. during the period 1921-25 when wages were not controlled but subject to the consideration of Conciliation Committees. Nor can one estimate what exodus of labourers from agriculture would have been brought about by any attempt to cut wages further below the general level prevailing in other industries. But taking 25s. as the lowest level reached in East Anglia during the years 1921-25, it may be assumed that for a time at any rate wages might have been reduced by 5s. a week. Reckoning that half a million workers would be affected, the gross cost of the Wages Act to the agricultural community of

England and Wales, for Scotland was not affected, would amount to about six and a half millions, a very liberal estimate.

Specific criticisms have been directed against the operation of the Marketing Acts both by producers and by consumers, on the one hand that they are maintaining high prices to the general public, on the other that they are interfering with the farmers' management of their businesses. It may fairly be said that these difficulties are inherent in starting a new system and will be removed as experience is acquired. But a more valid criticism is that the Acts are being administered in the interests of particular branches of the industry and not upon any general plan thought out in the interests of agriculture and the nation as a whole.

What should be the elements of such a national plan? First comes the broad consideration of the necessity of increased production from the land available, having in view the emergencies that would arise in case of war. Then there is the specific demand that our agriculture should be directed as far as possible to the production of those kinds of food which are necessary to furnish an improved dietary for the general population.

The medical officers who have been examining the dietaries of sections of our people have submitted conclusive evidence of the existence of widespread malnutrition, especially among children, such as results in a serious depression of the general health and efficiency of the working population of our country. In order to remedy the deficiencies the desideratum is an increased consumption of meat and live-stock products, of eggs, potatoes, green vegetables and fruit. These are all products of our soil and indeed are specially suited to our prevailing climatic conditions, but they are relatively dear as compared with bread, oatmeal, rice and other cereals, which remain the cheapest sources of the energy which is necessary to keep the human machine going, but are lacking in those accessories upon which growth and general health depend. Their greater cost, measured against the amount of energy they will supply, ultimately depends upon the higher amount of labour or of land that is required for their production. It follows that if we are to increase the extent of their general consumption we must find some means of cheapening the price the consuming public has to pay for them.

At this point one other element enters into the question. Under the present methods of dealing with the land available for cultivation in Great Britain we are producing only about two-fifths of the food we consume. Since only this measure of production is only being obtained by State assistance, it is clear that the State can exercise a choice of the kinds of production that should be encouraged in the national interest. From the point of view of meeting the nutritional requirements of our population the present policy of giving assistance to the growth of sugar-beet and wheat is ill-designed. Sugar is wholly and wheat almost wholly a supplier of energy; both are deficient in food accessories. Both are among the cheapest commodities in the world's markets. Sugar can no longer be produced from beet at a cost that will enable it to compete with cane sugar, the growth and manufacture of which has during the last quarter of a century experienced immense improvements from scientific research such as beet only had enjoyed previously. Everywhere beet-sugar production has become an industry depending upon heavy fiscal protection, and the twelve years' experience we have had of its growth and manufacture in this country affords no promise here of more efficient performance such as would render it an economic crop. Sugar-beet is now being grown for the bounty on land that is naturally fitted for vegetables; indeed one of the arguments for its maintenance has been that without it vegetables would become so cheap that small holders would be unable to live. Such logic has become universal where fiscal dealings with agriculture are concerned. As regards wheat the situation is different, for wheat is still a natural crop, perhaps the best crop, on much land in the Eastern Counties, the Midlands and the South of England. In these districts many farmers, who have adopted modern machinery for cultivating and harvesting the crop, are growing wheat at a cost that renders it profitable even at world prices. But the operations of the bounty are causing its extension on to soils on the one hand rich enough for more intensive cropping, on the other precarious for wheat as an economic crop, but available for live-stock production. Wheat again is one of the raw materials for the production of bacon.

It is, however, claimed that wheat and sugar are essential commodities in time of war, and therefore that a considerable nucleus of production should be maintained at home. But in such an emergency it is the total output from the land that matters; consumption may be restricted and production increased, but a great proportion of our food will still have to be imported. Under such conditions, as the experience of the last war demonstrates, the pressure on the shipping available is intense and preference has to be given to those commodities which involve the least tonnage. Now from that point of view wheat and sugar are the most concentrated of all foods, both in respect of their bulk and of their weight. Both again can be supplied by Empire countries across the Atlantic, from Canada and the West Indies, and they will come by the shortest and most open sea route, the only one that could be utilised during the late war. If we decide that we must accumulate a reserve of food to tide over the immediate stress on the outbreak of war, both wheat and sugar can be stored without deterioration for considerable periods, and at smaller cost than other foods. Thus the argument from provision for a state of war is in favour of leaving wheat and sugar among the imports and concentrating on increasing the general production from the land.

It is to that end that we should be directing our efforts; every farmer is aware that there is much land in this country that is under-farmed, that is short of capital, men and management. State expenditure may be better directed to bringing such land into condition for current production and to making it fit for intensification of output should the emergency arise. If the menace of war should be regarded as imminent, the preparations should be begun now, knowing as one does that time is required to get land into crop. I can speak with some experience during the late war of the difficulties and delays that attended the Food Production Campaign when a programme of intensive production had to be improvised. The national plan would therefore utilise the funds available for subsidies, levies and duties, in part to encourage the production that is needed in the interests of nutrition, in part to the reconditioning of the land that is at present not doing its duty.

But to return to the more immediate purpose of our discussion, how can we secure a cheapening of the kinds of food that should be produced for domestic consumption?

It is said that the farmers, the prime producers, have been the great sufferers from the low prices that have been of late years prevailing in the world's markets. Some critics of such Marketing Boards as are in operation assert that their policy is being directed to maintaining prices that will give a profit to men whose methods or conditions of production are below standard, and that in consequence no stimulus is being given to secure greater efficiency. The price of milk to go into consumption in its liquid state is being held up at such a high figure, roughly 1s. per gallon, that the total sale is not significantly increasing despite the propaganda that is being carried on. At the same time the [illegible]ction is increasing yearly, and more than 30 per cent of the total output is being sent to manufacturers, for which they pay 5d. per gallon or less, which is less than half the price charged to the wholesalers who pass the milk on to the public at two shillings a gallon or more.

But of even more importance in this question of cheapness is the very wide gap that exists for all agricultural produce between the price the farmers get and that which the public pays. There have been several examinations of the cost of distribution and retail sale, and the report has generally been that the charges for intermediary services are not unduly high if the business is to be carried on as it is at present. But this only strengthens the case for a complete reorganisation of the whole machinery of distribution and retail sale. I agree that this cannot lightly be attempted, nor without a considerable displacement of the existing traders, but it is an essential part of any national plan for getting the vital foods more cheaply to the public and therefore for agriculture itself. It is inevitable also that in such a drive for efficiency many farmers would be gravely incommoded and some even driven out of business if they could not adapt themselves to the new conditions. But as a whole the farming community would stand to gain. The demand for their produce would be increased, because greater production is needed, and they are the only people who can meet the demand. The little extra that means the difference between profit and loss to the farmers is small in comparison with the margin between their prices and the retail prices. None the less, in view of the assistance the State is according to agriculture, the farmers cannot claim to dictate what shall be produced or that it shall be produced by out-of-date methods. It is not unreasonable to ask that farmers shall fall in with a national plan that will bring to our population the food that is needed for its health, since it can be seen that great advances in production have been made since the war, and nowhere more than in Great Britain. The national plan would only render more general the examples that many of our farmers are already setting.

III—INCREASED MEAT PRODUCTION

Professor J. A. Scott Watson
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It seems to me to be necessary to consider the planning of our agriculture from two quite separate points of view. The one is the point of view with which this discussion is immediately concerned—the provision of an adequate dietary for the population in time of peace. The other is the security of a bare subsistence in time of war.

Planning for the eventuality of war is extremely difficult, because it seems impossible for the layman even to guess at the conditions that might prevail in any future war. On the one hand we might have a position like that which arose last time—*i.e.*, there might be a limited amount of shipping available, with heavy risk of loss and the necessity for a convoy system. Under such conditions the best policy would obviously be to use the available shipping to bring in those commodities which are cheap to buy and cheap to transport and which provide a maximum of calories in a minimum of bulk, leaving the home farmer to produce the " health foods ". We should do best to import our cereals, our pulse seeds and our sugar. We might also import our butter and cheese, only that we are unfortunately placed with regard to our two main sources of supply. New Zealand is on the opposite side of the world, and it is obviously very likely that Danish supplies would be cut off or diverted. But so long as we could import our grain and sugar, and produce at home our milk, potatoes, vegetables and eggs, we should be in a position of some security. In this case one policy would serve both ends—concentration of our home industry on the production of milk, meat, vegetables and eggs would be right in either case. Only there is one important reservation; it would be useless, in the eventuality of war, to have built up a live-stock industry dependent largely upon imported feeding-stuffs. The conversion of a possible human food like maize into the more attractive form of eggs and bacon is extremely wasteful of food values, and it would be one of the first steps of wise government, under the threat of famine, to put a stop to it.

But it seems that the case is completely altered if we postulate a condition of complete siege in the next war. In this case our main strength would lie in our fields of corn, potatoes and sugar-beet, for it is these that produce the maximum quantity of human food per acre of land. Moreover, it seems that efficient (if rather unpleasant) substitutes for the health foods could be quickly made available. For instance pasture grass is a cheap source of practically unlimited supplies of all the vitamins, so far as is known; and while grass itself is a food not very well suited to the human digestive system, it seems that it is a very easy matter to prepare from it a concentrated extract which contains all or nearly all the health-giving virtues of milk and fresh vegetables. Again, given a supply of starch or sugar and of ammonium salts it is possible, by the agency of certain yeasts, to manufacture large quantities of protein in a matter of days.

I have no wish to pursue the matter further. All that I want to say is that, if the extremity of a siege is to be feared, then we must not deny a place, in our farming scheme, to the highly productive crops such as wheat, oats and sugar-beet. Given the nucleus of an organisation prepared in advance, I believe that the country would be much less vulnerable in the matter of food supplies than many suppose. The more important essentials of this organisation would be, firstly, a nucleus of men skilled in arable farming; secondly, an adequate home supply of tractors and other farm implements; and thirdly, a reserve store of wheat sufficient to tide the country over a period of months.

Let me now turn to my particular subject.

It is clear from Sir John Orr's remarks that in any live-stock policy planned from the point of view of the nation's health, a supremely important place must be given to milk. Dr Kay, in the paper which follows, indicates how the desirable increase in milk production might be achieved; meantime, I think it is obvious that we cannot hope to double the home output of milk without keeping a great many more cows. Any likely or early improvement in the yield per cow would still leave a large gap between production and the volume of consumption that is regarded as necessary for the nation's health. When all our stock is dairy stock what shall we do for meat? This is the conundrum that has been set me. I cannot pretend to offer any complete answer. All that I shall attempt to do is to indicate some of the lines along which a solution is to be sought.

The dairy cow and her " followers " are direct competitors with beef cattle and with the low-ground breeds of sheep for the possession of our ordinary lowland pastures. They are scarcely competitors with the hardy beef breeds such as the Galloway, Welsh and West Highland, or with the mountain breeds of sheep, for the mountain and moorland grazings. They do not compete in any real sense with the pigs and poultry which, in the main, subsist on different kinds of food.

The problem of maintaining or increasing our output of meat thus resolves itself into three rather distinct problems. First is that of finding room, upon our better land, for at least some beef cattle and sheep along with the increasing quantity of dairy stock; second is that of increasing the output of our mountain and moorland pastures; and third that of increasing our production of pig meat, poultry and eggs.

Taking these in order, it must obviously be important to increase the output of milk per head of dairy stock; this is not merely a question of higher lactation yields, however obtained. Probably the most profitable line of attack is the eradication of the more serious cattle diseases. We know that the average productive life of our dairy cows is no more than about three and a half lactations, and since the average lactation yield is under 500 gallons, the average life's work of the British dairy cow is the production of something less than 2000 gallons of milk. It is well known that old age, which is the only inevitable cause of wastage in dairy herds, is in actual practice a rare cause. A cow, if she remains healthy, may ordinarily be expected to live to an age of about twelve years and to complete say nine lactations. The difference between the theoretical nine and the actual three and a half is largely accounted for by the incidence of four major diseases, each of which could almost certainly be eliminated, in a comparatively short term of years, by measures that are already known or are now in course of being developed. We have already many hundreds of tubercle-free herds, and the most recent technique for testing cattle is likely to make progress easier in the future. The same system of testing and segregation is being applied with promising results to contagious abortion. Early and fairly certain diagnosis of Johne's disease is now possible, so that there is now real hope of a large reduction in its incidence. Finally, for the common type of mastitis there is not only a technique for diagnosing the chronic case, but a curative treatment which is giving a large percentage of successes.

It does not seem too much to hope that, if the existing knowledge were applied to the full, the average working life of the cow might be increased to six lactations. Making allowance for the higher yields obtained in the late, as compared with the first and second lactations, this might be expected to raise the output of the average cow, during her whole life, to about double the present figure.

The effects of this would be very important. Firstly, we should obtain twice the quantity of milk without an increase in the output of the undesirable by-product, the cow-beef. This, at present, constitutes nearly half the total output of British beef, and its low quality is no doubt partly responsible for the decline in consumers' demand for beef in general. Secondly, we should obtain double the quantity of milk without any increase in our numbers of young stock. It is obvious that since we now require to replace something like thirty out of every hundred dairy cows each year, and since the average age of a heifer at first calving is three years, the number of young non-milking dairy cattle must approach very closely the number of cows. It ought to be only half as many.

This latter advantage could be exploited in various ways according to the circumstances of each case. The less promising or less well-bred heifer calves might simply be scrapped, with the aim of increasing the average milk yield of the remainder. Alternatively the poorer milkers among the cows might be mated to a beef bull, to provide raw material for the beef industry. This indeed would not be a good solution in the case of herds of Channel Island cows, for it is doubtful whether these can produce useful beef calves however they are mated. But the other breeds, which are in a large majority, could produce very useful cross-bred stores.

The eradication of the diseases I have mentioned is thus an object of prime importance in relation both to the beef and to the milk supply. Unfortunately, it is certain to make but slow progress unless it receives an increasing measure of support and encouragement from the State. We want some large-scale demonstrations and we need an educational campaign. We require financial assistance for testing, and some system of compensating the farmer who is prepared to slaughter diseased cattle. Such measures are already in force in Holland and elsewhere. There is little doubt that the devotion of State moneys to the eradication of disease would prove a highly profitable investment for the State. The farmer is here, as in many other directions, unable to make the investment because he lacks the capital.

Turning to another aspect of the matter, there are, of course, various possible means of increasing the stock-carrying capacity of our lowland farms. I can take time to mention only two. One method is the increased use of the plough. It is true for large sections of the country that grass leys are definitely more productive than permanent pastures and meadows. Stapledon, I am convinced, is right in his view that the best way to maintain the productivity of a large proportion of our grassland is periodically to plough out and re-sow. Moreover, the plough is still the best remedy for many of the ills of our stock, such as hoose in calves and stomach worm in sheep, which are among the most important causes of inefficiency and loss in live-stock production.

Any policy designed to encourage the live-stock industry at the expense, say, of wheat and sugar beet, runs the risk of sacrificing these arable crops for nothing. The Eastern Counties of England, for instance, would certainly produce less and not more beef and mutton if sugar-beet and wheat were to drop out of the system of farming.

The other main hope of increasing the stock-carrying capacity of our lowland farms is improved methods of fodder conservation, particularly grass-drying. But the subject has been so constantly before the industry during recent months that there seems to be little purpose in going into it again now. The experience of the present season is being assembled by the Agricultural Research Council's Committee on Fodder Preservation, and the evidence will, I believe, be collated and published before the spring.

A relatively minor development bearing on the general question of the supply of health foods is the recent tendency, most marked perhaps in Norfolk, to combine the production of vegetable crops and meat—to replace the roots of the old rotation by a dual-purpose crop. The supply of home-produced fresh vegetables is bound to fluctuate so long as the main crops depend on the vagaries of the weather. We have had an example during the past season, greenstuff having been almost unobtainable in early spring and almost unsaleable by late summer. Glass culture, overhead irrigation and canning do, of course, all tend to level out supplies, but as regards the ordinary staples—sprouts, cabbage, beetroot, carrots, cauliflower, peas, runner beans and the like—it is impossible to ensure the full supply of the market without the risk of frequent and heavy over-production. Moreover, there is inevitably, in many cases, a considerable proportion of low-grade produce from these crops. It seems that the best solution of the problem is large-scale production with sheep, cattle or pigs to consume the low-grade produce, the residues and the surpluses.

Turning now for a moment to our hills and moorlands, it is obvious from recent work that vastly greater relative increases in output are possible there than on the good low-ground farmlands. It is difficult, by any known means, to get a Leicestershire fatting pasture to fat more bullocks, or a Boston silt to grow more potatoes. In these cases the soil fertility is near its optimum, and to get better results we should have to control the sun and the rain. By contrast it is easy, from the technical point of view, to double, or treble, or more, the output from much of our poorer mountain pastures. Professor Stapledon's work at the Cahn Hill Station and Dr Ogg's in Lewis both show these relatively enormous increases in productivity. Our mountain lands are therefore an important potential source of a largely increased supply of meat. So long, however, as we maintain our present national outlook towards the land, only sporadic and piecemeal improvement will be carried out. The ordinary private landlord will undertake the work only if it is likely to prove a good investment in the ordinary business sense, *i.e.*, will return more than the ordinary interest rate. I am not submitting that this attitude is wrong, but it is worth observing that it is being generally abandoned in many other countries. The reclamation of the Pontine marshes in Italy is unlikely to return its four per cent, and yet it is difficult to say that it will not prove to have been worth while. The same remark applies to the great Dutch Zuider Zee scheme and to much of the moor and marsh reclamation that is going forward in Holland, Germany and Denmark. Can it be that these countries are wiser than we? They are turning their spare energy into the creation of permanently valuable assets. Is four per cent really the sole criterion on which the decision should be reached?

The rest of my conundrum seems easy to answer. The production of pork and bacon, of chickens and eggs does not require any considerable amount of land. We could, if necessary, build our piggeries five storeys high, as we are already building our battery brooders and hen batteries. But any expansion of these industries, upon ordinary business lines, must be based on increased imports of feeding-stuffs. We cannot, I believe, with our climate and our standards of living, produce food energy and protein to compete with imported Argentine maize, Manchurian soya beans, Persian barley and so forth. The pig and poultry industries have expanded very rapidly in recent years, and either or both could be further expanded at will and to any desired extent, by relatively cheap measures of assistance. But the expansion would depend largely on increased imports. It is milk, beef and mutton that can be produced in greater quantities from our own soil.

IV—INCREASED PRODUCTION OF MILK

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Introduction.—It is a suggestion that has, at least, a considerable body of evidential support that the present sinister state of world affairs, when ruthless force, destruction, extermination and still further tightening of belts seem to be the order of the day, is the result of prolonged malnutrition in the countries where these developments are most rampant. Whether or not this is the case it is refreshing to have before us this morning one of the few really constructive ideas of the present decade—the marriage of health and agriculture.

Of the specific recommendations made by the opener, the consumption of a considerably greater quantity of milk per head by the people of this country is, from the standpoint of the improvement of the national health and physique, as it undoubtedly is from the point of view of agriculture, the corner-stone. In the present discussion I am not concerned directly with the health aspects of this suggestion, nor with the economics of the present low consumption per head, nor with the important question that is implicit in Sir John Orr's suggestions—the educational technique that would be necessary to re-orientate the nation's dietary habits—but with the problems that the effective putting into practice of the suggestion regarding milk would raise for the dairy farmers of this country, and with a forecast of the way in which the very real difficulties could be met. In the short time available, I can deal with only a fraction of the problems that would ensue, and that only in outline.

May I say at the outset that I am convinced that the enormous increase of milk production foreshadowed could be met, given a few years' time, by British dairy farmers. There is, of course, no question that they would be very glad indeed to function more efficiently and abundantly in the support of national health *if an economic framework could be devised* in which this increased activity could take place.

Quite apart from subsidies, direct or indirect, it must be admitted at once that increased organisation (or perhaps it would be better to call it co-ordination) of the whole industry would be required. For milk production a co-ordination mechanism is extant in the English and Scottish Milk Marketing Boards, a mechanism capable of considerable further development. For milk distribution an organisation of similar efficiency and power is at present lacking. The whole industry requires unification from the farmer to the roundsman if safe milk is to reach the consumer at minimal economic cost.

The dairy industry has, indeed, already gone some of the way towards meeting increased liquid requirements. For several years, mainly as a result of the unprofitableness of most other forms of farming enterprise, there has been a tendency to increase milk production. During the last two or three years whilst the English Milk Marketing Board has been in action and accurate figures for milk production in England and Wales have at last become available, more and more milk has been produced—in the past year some 335,000,000 gallons more milk than is required on the liquid market at present rates of liquid milk consumption. Allowing for the 20 per cent extra to immediate liquid sales, which is considered by the recent Whitehead Committee of Reinvestigation to be the safety margin (and much of which must inevitably go to " manufacture "), the net excess is 213,000,000. In other words, there is already a margin, over and above the safety margin, which could be used to meet some at least of any increased liquid demand.* Much of this milk which now goes to " manufacture," is not, of course, lost completely as a food-stuff, but returns as butter, cream, cheese, etc., to the market. But a fairly large proportion of the food value of the milk, has, in fact, been lost in the skim milk, whey, etc., much of which is now destroyed.

With reasonably efficient organisation of the dairy and pig industries, if an increase also took place in the consumption of pork and bacon as foreshadowed in the general scheme put forward by Sir John Orr, much of our " safety margin " could be manufactured as at present, but there should be almost complete utilisation of the whey and skim milk for pork and bacon production.

That there is already a great tendency towards increasing production is, of course, well known. Unfortunately, although the accumulation of knowledge gained through research in the past decades has made our potential ability to increase further both the quantity and the quality of liquid milk production very large, real efficiency *and quality* of production, owing to factors which have prevented the profitable utilisation of this knowledge, have increased only very slowly. Less than 20 per cent of the producers have as yet been able to reach the standard fixed by the English Milk Marketing Board for the accredited penny per gallon. No one can say that this standard is unduly high. I am sure that a 20 per cent efficiency of quality production will not be tolerated for long by the dairy industry, now that it is on an organised footing. I mention it now because I feel strongly—and shall return to this point again—that it is of first importance to guard against any diminution in quality as a result of an increasing quantity of milk being produced in this country. In fact, quality and quantity must increase together.

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*One of the advantages of the scheme for increased consumption of liquid milk at home is that it will relieve our New Zealand, Australian, and Canadian cousins of any fear that our increasing surplus of milk over that now required for liquid consumption will make appreciable inroads into their market in this country for butter and cheese.

Milk from Abroad.—What about possible imports of liquid milk from abroad? Could any part of an increased demand be met in this way? Milk is, of course, in a different category of perishability from most other food-stuffs, even from fruit and vegetables, but methods of processing are now known—there are at least two—which will preserve its nutritive value in the liquid state over several days or even weeks. One of these methods is fairly cheap and affects the flavour; the other is expensive, but affects the flavour much less.

Under the Milk Marketing Schemes, importation of liquid milk from abroad into the United Kingdom is virtually impossible, and even if it were made possible, it would be a long time before the hygienic quality of foreign milk could be improved and the costs and difficulties of transporting liquid milk from abroad overcome sufficiently to have much influence on liquid milk production at home. For present purposes, we can, I think, dismiss this possibility. We cannot, however, dismiss the possibility that if an improvement were brought about in the methods of drying or evaporating milk which would result in a product that could readily be made up again by the consumer into liquid milk, without change of flavour, the grocer might well become an important, if not the principal, distributor of milk. Drying has, however, been going on for a long time now without solving the all-important flavour problem.

Let us consider a little more closely the dimensions of the problem which is before the milk industry.

Dimensions of the Problem—

	Pint
1. *Present milk consumption per head per day*—	
Market Supply Committee figures for United Kingdom (1934)*	0·40
Milk Marketing Board figures for England and Wales (1935-36)	0·44
St. Louis, U.S.A., lowest of American cities	0·42
Boston, U.S.A., highest of American cities	0·78
2. *Desirable consumption*—	
Actual consumption* in United Kingdom at high income levels with present food habits	0·80
Nutritional authorities' recommendations for optimal consumption	1·0 or even more

It will be seen that the dimensions of the problem are an increase of about 100 per cent in the consumption per head on the lower scale, or 150 per cent on the higher scale of desirable consumption.

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* Orr, *Food, Health and Income* (Macmillan, 1936).

3. *Actual and required production—*

	Gallons
Total gallonage required for 0·8 pint per head per day for the whole population of the United Kingdom (allowing a 20 per cent margin for safety)	=2,000,000,000
Total gallonage required for 1·0 pint per head similarly	=2,500,000,000
Present production of milk for liquid market and for manufacture approximately	=1,200,000,000
Turning all this milk into liquid market, extra production required at 0·8 pint per head per day ...	= 800,000,000
or, at 1 pint per head per day ...	=1,300,000,000

To produce 1 pint per head per day means either—

(1) An increased yield per cow from 450 gallons to to 990 gallons; or

(2) Rather more than doubling the number of dairy cows; or

(3) More probably a combination of smaller increases in both of these.

Taking these figures into account in relationship to the limited area of these islands from which the increased milk production has to be met, it is quite clear that greatly increased efficiency will be required in every branch of dairy husbandry. I will now deal with some aspects of this question of increased efficiency.

Milk Quality.—There is no doubt that the milk industry is seriously disturbed about milk quality. Would not the tendency be for quality to decrease with increased output?

There are two aspects of quality which have to be very carefully considered. The first relates to the compositional quality which is closely related to the nutritional quality of milk. The consumer must receive just treatment. The chemical quality of some of the milk produced in this country, quite apart from sophistication (which I think is not very common) is poor. The percentage of total solids in the milk as it comes from the cow may be so low that in effect a pint of such milk may contain in food values only 80 per cent or even less of the value of a pint of good normal milk. But, at present, the price paid by the consumer per pint remains the same.

In securing an increased consumption of milk per head, the nutritional quality of the milk must certainly not be diminished. It would indeed be possible to increase appreciably the consumption of milk solids per head without increasing the volume consumed per head, if sufficient attention were paid to compositional quality.

It seems to me that in any properly organised and controlled milk industry (and no other type of industry can hope to provide the increased production we are considering) the producer of milk for liquid consumption should be paid for his milk on a basis which includes a factor for compositional, that is, nutritional quality. Maintenance of compositional quality is, in general, an excellent criterion of efficient dairy husbandry.

It means, without any doubt, nation-wide milk-recording, and recording of quality as well as quantity. Quantity may be recorded on the farm, but fat-testing and still more the assessment of total solids content of milk requires outside assistance. No farmer can assess the progress he is making in improved yield per cow and in quality of milk without systematic recording, still less can he adopt a satisfactory breeding policy for better stock without it. The proof of any policy is in its results. I will go no further at present than to say that whereas the average yield per cow per year in this country is about 450 gallons, the average yield in milk-recorded herds is 704 gallons—55 per cent more. In fact, if, *without increasing the number of dairy cows, the average yield per cow could be raised to that of milk-recorded herds*, our problem of increasing home production of milk to meet the level of consumption advocated this morning would be more than half solved.

The other aspect of quality has already been recognised as a basis for increased payment by the Milk Marketing Boards, namely, hygienic quality. If accredited licences are being given on an honest basis, then milk from accredited herds will be cleaner and less likely to convey disease than milk from non-accredited herds. If to the accredited premium could be added a compositional quality premium based on authentic milk-testing records, many of us would feel that the Boards had taken a big step forward in the real improvement of the milk supply, and that the foundation had been properly laid for the increase in liquid consumption that we are considering to-day.

Another necessity is increased research on direct control of milk quality. Valuable indications—first steps towards eventual control—have recently been obtained by a small group of investigators working at the National Institute for Research in Dairying at Reading, and they have found during the last two years methods for increasing, within limits, the compositional quality of milk almost at will. Most of the methods are at present entirely uneconomic and it has yet to be decided whether their effect on the cow is or is not harmful. Progress is, however, being made, and I have reason to believe that eventually we shall be able effectively and economically to control, at least within certain physiological limits, the compositional quality of milk.

Milk Yield per Cow.—Our present annual production has to be increased by some 120 per cent to meet the pint per day. If our present average yield of some 450 gallons per cow per year could be increased by 120 per cent to 990 gallons it would still be well within the powers of quite a number of modern cows. There is, of course, a danger in pushing individual volumes too far, and our farm standards must not be set by the Olympic records of what are, in some instances, grossly abnormal animals secreting milk of questionable compositional quality.

Any complete answer to the important question as to what is the *optimal* economic yield per lactation for the production of good-quality milk (with the preservation of the health of the cow for several lactations) cannot as yet be given. It can safely be said that it is considerably greater than the 450 gallons which is the average yield at present and considerably less than the 2,000 gallons or more of the dairy show prize-winners. It will, naturally, vary with the breed and the climatic conditions of the district in which the cow is living. As Buchanan Smith has pointed out, the 10,000 gallon cow—*i.e.*, one that gives an average of 1,000 gallons per lactation for ten lactations—will become more and more the volume standard to be aimed at if the intensiveness of home production increases as it should. What we must have is a disease-resistant, durable cow.

The varying ability of different cows to utilise food-stuff for milk production is an aspect of efficiency which has hitherto received little attention. If the fraction of the food eaten which a given cow turned into milk could be accurately determined—as is quite possible—and animals could be bred for increased efficiency in this direction, then there is little doubt that the total gallonage produced per ton of mixed food-stuffs could ultimately be increased.

Increase in the number of Dairy Cows.—Even assuming a reasonable increase in the yield of milk per cow and of her food-transforming efficiency we should require a large increase—possibly 80 to 100 per cent—in the number of dairy cows.

An increase of this magnitude clearly cannot be achieved overnight. We are not yet, for example, in the position to control the sex of our calves before birth and to increase the proportion of females born. The dairy cow in this country gives an average of something rather less than one viable calf per year, and assuming, as is very near the case, that half of these calves are females, apart from disease it should be easily possible to double the cow population of the country in three years. Actually, according to Hunter Smith, for every cow which enters into a milking herd, an average of nearly four calves are born. Since the milking life of a dairy cow is at present under 4 years, it is clear that the rate of increase must at present be very slow indeed. At the present rate it will take several decades to double our total number of cows.

I thoroughly agree with Professor Scott Watson that it is disease, particularly contagious abortion, which is the most serious check at present to the natural rate of increase. The incidence of this disease is not, unfortunately, discriminatory against the poorer herds. An increase in number of dairy cows, with increased density of cow population, will require the very careful collaboration of organised, preventive veterinary medicine with an organised dairy industry. Whilst disease is being controlled and reduced, it is possible that some temporary solution may be obtained by a more stringent isolation of herds. Double fencing, or belts of arable or grass-producing land—for dried-grass manufacture—between herds, and, of course, efficient quarantine arrangements, will all help.

Another serious difficulty is that our stock of really first-class cows from which breeding ought to take place is not very great, nor are our proven pre-potent bulls very many. Part of the latter difficulty can, however, be overcome by artificial insemination, as with suitable precautions the semen from a single artificial copulation will suffice for the insemination of twenty or more cows. A large herd unit or a series of co-operating units, with enough cows in season at one time, or, alternatively, the use of methods for artificial bringing into season, is in these circumstances particularly necessary. Artificial insemination also avoids possible infection of the bull and spread of disease in this way.

It is a mistake to believe that milk production in these islands to-day is entirely a home industry, since in the average dairy farm, although a considerable area may be given over to food production for the cows, a large amount of food must be bought in from outside. In fact some 55 per cent of the production cost of a gallon of milk goes in purchased food. Most of this is concentrated food produced abroad under conditions which are fundamentally better for photosynthesis than conditions here. Parts of this country are, however, excellent for growing grass. All dairying experience and science goes to show that young grass from high-quality pasture is the food *par excellence* for the lactating cow, and recent work has shown that the careful drying of such grass does not diminish its food value. Most of us are familiar with the methods employed, and there is every reason to suppose that with an increasing demand for liquid milk, dairy farmers will turn more and more to dried grass as one of the main articles of food for the production ration. Without the tremendous advances in our grassland knowledge during the past few years, combined with the recent developments in the technique of grass-drying, the general problem of greatly increased home production of food which was set by the opener of this discussion would be almost insoluble. At least in certain parts of Great Britain with a reasonably high rainfall it is now possible to obtain, by cutting at intervals throughout the summer, yields of high-quality dried grass in quantities which are not only two, three or more times greater in weight than even a good hay crop from the same fields, but have the nutritional value of concentrated protein food-stuffs, and that independently of the weather. It is, of course, likely that the demand for imported "concentrates" will also be greater if the number of dairy cows is being increased, despite the widespread utilisation of dried grass.

It is to be remembered that dried grass has beneficial effects on the nutritive quality of milk, particularly during the winter months. In fact, whether we increase our milk consumption to a pint or not, I can see no alternative but a rapidly increasing interest in grass farming in this country in the near future. If we are to bring about appreciable increases in milk production such increased interest followed by action is essential. To those in parts of these islands that have a fertile soil, a high rainfall, and access to reasonably cheap supplies of fuel, particularly, *e.g.*, to our friends in Ireland if they can overcome the fuel difficulty, drying and baling of grass may become a lucrative activity in the near future.

Increase in farm accommodation and facilities.—As Stapledon has pointed out, the great majority of dairy farms in this country suffer at present either from inadequate, unsuitable and labour-wasting cow accommodation, or from inadequate water supply for watering and cleansing purposes, or from both. These two handicaps are chiefly responsible for the relatively low percentage of milk producers that have qualified for the accredited penny. With a large increase in the number of dairy cows, adequate capital must somehow or other be forthcoming to provide sufficient properly planned accommodation on the farms, and what is equally important, an ample and pure water supply.

One possible means for providing part at least of the capital for improvement and extension of accommodation might well be loans from or through the Milk Marketing Boards at a low rate of interest to owner-occupiers or to landlords for approved improvement schemes, with amortisation out of the quality premiums. A pure and adequate water supply to the farm ought, it seems to me, to be the responsibility of the local authority, possibly with assistance from a national grid supply. Any considerable increase in cow population will redouble the present urgent need for water facilities. Incidentally, a large amount of labour could be given valuable and productive employment for some years in the provision of improved dairy accommodation and water supply, whether or not our milk production is to be markedly increased.

Increase in Manuring.—Even if there is complete return of farmyard manure to the land, good milk takes ultimately from the soil, for every 100 gallons, 1·7 lb. of lime (CaO), 2·3 lb. of phosphoric acid (P_2O_5) and 1·8 lb. of potash (K_2O), not to mention large quantities of nitrogen and small quantities of other mineral constituents, such as sulphur, iodine, magnesium, copper and manganese. These valuable minerals, most of which never return to the land, but are so disposed of in our sewage systems that they finally are lost in the sea, must somehow be replaced in the soil. The loss goes on, day in day out, winter and summer, from every dairy farm, and, with more intensive milk production and increased grass removal, will be greatly increased. According to the authorities on grassland, at least 50 per cent of the grazing area of this country is at present seriously under-limed, and an even greater proportion under-phosphated or not phosphated at all. One clear outcome of increased consumption of milk per head will be the need for very careful investigation of economic manuring for intensive grass production. The limiting factors may well be other than the major constituents of grass and milk just mentioned. The economic recovery of valuable nutrients and salts from town sewage and their re-utilisation on the land may or may not be a will-of-the-wisp, but even on the farm better use will have to be made of solid and liquid manure in future.

Increase in area required for dairying and increase in size of the individual dairying unit.—I must raise now two controversial points. They are—(1) Would a largely increased area of land be required for an increased milk production of the dimensions we anticipate? (2) What, if any, increase is necessary in the size of the efficient dairy-farming unit in view of modern developments in dairy-farming technique?

(1) An increased total area would undoubtedly be required for this milk production, but, I think, not a *greatly* increased area. It is difficult to predict exactly how much, but I believe that to get a 100 per cent increase in milk production, which increase is bound to take several years to achieve, probably not more than a 20 per cent increase in area would be required, possibly even less. My opinion is based on the following considerations:—

(*a*) The example of countries such as Denmark, a country not inherently more fertile on the whole than England and Wales, though it cannot properly be compared with Scotland. In Denmark the production of milk per acre of agricultural land is vastly greater than here. She is said to produce an average of 704 gallons per cow. Our production in England and Wales is about 450 gallons. Denmark has an average of 133 dairy cows per square mile of agricultural land—the average in England and Wales is only 65. Her yearly milk output per acre of agricultural land is about 147 gallons, against some 46 gallons only for England and Wales—*i.e.*, some three times as great.

(*b*) We have not yet utilised to any very large extent our rapidly increasing knowledge of efficient grass production and preservation. It is well known that over vast areas of this country our existing pastures are poor and could be greatly improved in productivity by applying available knowledge. Estimates vary as to the extent of this potential increase—Stapledon believes that as much as a threefold increase in productivity may be looked forward to.

(*c*) The yield per cow is low at present, but is steadily increasing, and probably needs only a slightly keener realisation of the need for it, and appreciation of the best methods of obtaining it, on the part of the dairy farmer, to increase the individual yield very considerably.

(*d*) A spur to increasing efficiency of utilisation of the dairy-farming land would be the pressure on available areas from other branches of agriculture, *i.e.*, meat, fruit, vegetable, potato and egg production, which would be stimulated under the increased consumption requirements put forward by the opener of this discussion.

It may be urged that comparison with Denmark is valueless since she is a dairying country and England and Wales are not, or at least not to the same extent. Actually, of her available area, Denmark has not a much greater fraction devoted to dairy farms than we have. She has, for example, as much as 41 per cent of her agricultural area under cereal crops. Where she has the advantage is in a greater density of population of dairy cows per acre and a larger yield of milk per cow. What can be done by Danish farmers can, if necessary, be done by British farmers also.

A fairly large increase in the area required for dairy-farming, and the pressure which the increased demand for other agricultural products would place upon the limited area available, would require a nationally organised policy of reclamation of submerged or fen land and the bringing under grass of moor or heathland. The psychological value to the nation of a steady reclamation policy would be incalculable. It would at least be one unmistakable indication that democracy was not so preoccupied with the negative virtues of defence and mere survival as to be less capable than any totalitarian régime of positive movement towards increasing life and potentialities of consumption.

(2) The other controversial point is the optimum area desirable for an efficient modern dairy farm. If we are to produce in the relatively small area of this island enough milk and other perishable agricultural products to meet the increased consumption which has been suggested, our methods of production will have to be highly efficient, *i.e.*, the economic cost of our products will have to be as small as we can make it. In general this means a reduction of overhead and labour costs per gallon of milk by distributing inevitable costs over as many gallons as possible: in effect, mechanisation as far as possible. This process has, in fact, been going on slowly for some time. Ashby states that whilst 55 hours of manual labour were required for every 100 gallons of milk in 1890, only 37 are required to-day. Yet the average dairy herd at present is still only about 16 milking cows strong—16 cows have to bear most or all of the overhead expenses of the farmstead, the cost of coolers, sterilising equipment, transport, etc. It is quite clear that only in exceptional districts can 16 cows be a unit of optimal size. If used at all on such a farm, machines must inevitably be used at far below their efficient load. In practice, probably no modern machines, and little skilled labour outside the farmer's family could be afforded.

It will be noticed that under the English Milk Marketing Board the *more efficient producers are the larger units;* thus whilst only 15 per cent of the producers are accredited, they produce one-third of the total milk, *i.e.*, their milking herds are probably over 30 strong. In the attested herds in Great Britain, representing presumably a still higher stage in dairy-farming efficiency, the average milking herd is still stronger.

To breed, feed and manage a herd of high-yielding, healthy cows needs, *inter alia*, division of labour, efficient purchase of foodstuffs, manures and other outside materials, and an area large enough to bear mechanisation, to support a grass-drying machine, and to permit of segregation of infected stock. I am not sure that it does not also require a resident specialist for rationing, for grassland and manures, and for veterinary work. In short, I feel that an increase in the average size of the dairy-farming unit (or some co-operating equivalent) is to be expected in the not too distant future, an increase eventually, perhaps, to several times the present size. In the meantime, experiments carried out in this country, extending over some years and on a strictly economic basis, with dairy-farming units of size 600, 1,200 and 2,000 acres, fully mechanised and with resident specialists, would be most illuminating.

As regards the possibility that, in addition to an increase in the size of individual herds, an increase would also be required in the number of milk producers, it seems to me that a hint might well be taken from the new regulations for issue of licences to motor drivers, in that any new entrant should have to pass a test—in this case the tuberculin test for the whole of his herd—before being given a licence to produce milk for liquid consumption.

In summary, the problem of markedly increasing home milk production set to the dairy farming industry of these islands by the opener of the discussion could be solved, probably without serious encroachment on land required for other purposes, provided the essential economic framework could be devised and efficient organisation, at present in embryo, could be developed both on and off the farm.

An increase of 30 per cent or so in liquid milk production could be attained fairly readily, but to provide the rest of the 100 per cent increase required would be a relatively slow process and could only be effectively achieved by a general increase in the efficiency of production resulting from the dissemination and adequate utilisation of scientific knowledge already available. The fruits of research not yet mature would accelerate progress, but there is little doubt that years—possibly a decade or more—would be needed.

Possibly the problem of production would be, in practice, the lesser of the two main problems concerned with the *maintenance of an adequate consumption* of milk. The other problem, that of educating the public in dietetics, the consideration of which is altogether outside the scope of the present paper, will, in my opinion, be a tougher problem altogether. You may provide milk for the public, but you cannot make them drink it against their wills and prejudices. The solution of this problem, like that of so many of the difficulties facing this country, is bound up with a generally higher standard of education and in particular a far more widespread and thorough training in biology for a large proportion of the community.

BREEDING FOR MILK YIELD AND UNIFORMITY[1]

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The optimum yield of a dairy cow is a matter for the decision of the economist in conjunction with the producer; in other words it is determined by market requirements in relation to the environmental factors of the farm and the capacity of the farmer. Considering the complexities of market, dependent not on milk alone, but on beef also, the variety of types of farming and the varying capacity of the human race, the combinations and permutations of these factors, if analysed to the last degree, become infinite. Thus there can never be a best breed or best type of dairy cow, though it is possible to discern leading types with various optimum yields which can be reckoned to be generally the most suitable to particular types of farming.

It is the function of the geneticist, not to determine the optimum yield for any type of farming, but to advise the farmer how he may secure that yield with a reasonable degree of accuracy. At the present time there is a very wide variation in the lactation yield of dairy cows, which may normally extend anywhere from 500 to 3,000 gallons with occasional animals below and above these limits. Even within a breed the variation is great, and it is greater in some breeds than in others.

At the outset of any discussion of this nature there crops up the ancient question of the value of dual-purpose cattle. In one sense beef and milk are competing functions in that it is unreasonable as well as bad physiology to expect them both to be obtained to a superlative degree in one and the same animal. In another sense they are not competing since modern market requirements demand beef from animals under two years old, while sexual maturity (save in certain breeds) is not approached till six months later, nor achieved till at least three years later. Furthermore, the high producer for milk has much in common with the good beef producer in that both demand a sound internal constitution. Research has shown that there is no great difference between the skeleton of the highly-organised dairy cow and that of the very specialised beef one.

Briefly, the position may be summed up by saying that the possibility does exist of the 1,000-gallon cow which, mated to a suitable bull, can give daughters of equal milking capacity, and sons with carcases of beef of reasonable quality, though not, of course, prime Scots.

Looking at the problem of such a dual-purpose cow we are faced with one of the most difficult of genetical problems. To fix in a strain one productive quality is a difficult task, since any single quality is dependent upon a multitude of genes. To fix two productive qualities does more than double the difficulties for it is a matter of geometrical, rather than arithmetical, progression. I will return to this after dealing with the fixing of milking capacity in a purely dairy type of cow.

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[1] Paper read before Section M of the British Association at Blackpool, September 1936.

In such a type, according to other circumstances, there is justification for various levels of production. Amongst a certain section of the agricultural community it is customary to decry the cow that is a phenomenal yielder of 3,000, or even nearly 4,000 gallons. There is, however, economic justification for such a type of high-powered animal, and given certain circumstances, it may be the most remunerative type for the farmer to keep. But, putting this question on one side, if a somewhat more moderate yield, say 2,000 gallons, is desirable, then to get the breed type fixed there it is desirable to encourage the phenomenal yielder, in order that her blood may raise the average of the breed and keep it there when it is reached, for the higher the yield the greater is the tendency to regression.

Phenomenal cows are thus to be encouraged. That in the past extraordinary yields have frequently been associated with animals unable to stay the course is no justification for believing that phenomenal yield is synonymous with a short life. Indeed recent records of the heaviest milking breed we have, the British Friesian, already belie such a statement. The deduction to be made is that it is essential to select not only for high milking capacity, but also for—to borrow a simile from the motoring world—a chassis worthy of the powerful engine of milk secretion. In other words, selection must also be made for sensible udders, good legs and feet, as well as robust constitution. Hence it is that the scientist heartily endorses lifetime rather than lactation yield as the basis of selection.

The same principle applies to those other dairy breeds whose characteristic is a more modest optimum of production, say 1,000 gallons with from 400 to 450 lb. of butterfat. To get the average of the breed to that figure and to maintain it there demands that the principal pedigree breeders, whose herds serve as the source for the improvement of the others, should have a standard definitely higher than the optimum considered desirable for the breed.

In discussing the use of very high yielders as a means for the improvement of the average there are two additional points that must be taken into consideration. The first is the cost of production. Observation appears to indicate that some cows are more efficient as converters of food-stuffs into milk than are the majority of the breed. Whether this difference is sufficiently great to justify selection for the more economic cow has yet to be investigated. In meat production it has been shown that both steers and pigs raised under identical conditions show considerable individual variation in their efficiency as producers of beef and bacon respectively. It cannot be denied that certain high-yielding dairy cows only achieve their extraordinary records on diets that are quite uneconomic for the purpose of simply producing milk to be sold at under 1s. a gallon. Of course, it may be due to the ignorance of the owner that a particularly fancy ration is fed to such a cow.

This leads to the second point of assessing the true or genetic yield of a dairy cow. So many, besides genetic, factors affect the yield of a cow, and particularly of a high yielder. Generally speaking, I think it is easier by means of adequate management and nutrition to increase the yield of a high- than of a low-yielding cow. In other words, it is easier for the cowman to push the yield of a cow up from 1,500 to over 2,000 gallons than it is to increase that of a low yielder from 500 to 1,000 gallons. This increases the difficulty of selecting for high-yielding cattle, and may account for the slow progress that some allege is being made at present.

Whatever the type, it is essential in selecting the bull to consider him from the point of view of whether the yields of his daughters are uniform or not. Judged by the progeny test, two bulls may have daughters of equal average production, say 1,000 gallons. But the daughters of the first may vary greatly, say from 600 to 2,000 gallons, while the yields of the second may fall between 800 and 1,200 gallons. In the early stages of breed improvement the first type of bull may be the more useful, and in the past, since hitherto it has not been customary in assessing the value of a bull to consider the yields of all his daughters, more emphasis has been laid on this first type. But the future lies undoubtedly with the second type, the bull that transmits uniformity and proves himself prepotent, and therefore " homozygous " for the desired qualities.

A few years ago I made a study of the inheritance of milk yield in three pedigree Dairy Shorthorn herds. I was particularly struck by this point, the variability of the yields amongst different groups of daughters by different bulls. In this connection I quote one instance, typical of several, but which we can consider to be accurate in view of the number of daughters of each bull, and of the facts that these daughters were out of the same population of cows, and that they were all reared and milked in one herd at the same time. I also append figures of one bull used in the same herd whose daughters were remarkably uniform in their yields. The figure in the right-hand column may be taken as a statistical indication of variability; it is based on the average of the summation of the squared differences of all pairs of daughters sired by that bull. Most of the daughters' records are based on the average of two or more lactations:—

Bull	*Daughters*					
	Number	Average Yield Galls.	Lowest Yield Galls.	Highest Yield Galls.	Difference: Highest —Lowest Galls.	Variability
C.D.M.	41	639	389	883	494	36,389
K.J. ...	15	641	302	1,175	873	93,279
Low Variation						
C.W.E.	9	693	606	779	173	7,448

One further point as regards improvement in the purely dairy breeds and that is that a breeder should not endeavour to fix too many points at once. He should do it step by step. First reasonable yield, then improved butterfat, next the type of the lactation curve. The same holds true for conformation, the udder, the legs and so forth. By this I do not mean that in pursuit of his first he should ignore his second and subsequent objectives, but that he should lay less stress on them. If our breeding policy were organised on a national basis as it is in Russia, then certain herds would be famed for the excellence of certain characters, and other herds for other qualities. Thus a breeder, having fixed certain desirable qualities in his own herd, could obtain a bull from another from which the faults in his own herd had been eliminated. Careful selection would thus enable the next desirable characteristic to be incorporated without the loss of those already fixed.

As a matter of fact this is actually the system which has been evolved in this country. But it is open to question whether further substantial advance can be made without rational organisation and an enlargement of the herds in order that selection may operate more effectively. Personally I believe that the future of live-stock improvement demands the large herd.

Reverting now to the dual-purpose beast, the same principle applies of intensive selection for a limited number of qualities at one and the same time. I know of no dual-purpose breed where there are not distinct types depending on whether the greater or less emphasis is laid on beef. This is one of the principal criticisms made by those who decry the dual-purpose animal. But is it justified? Different circumstances make different demands on the dual-purpose animal, and in supplying a variety of types surely the breeder is meeting a want. That is correct so long as the breeder in his own herd maintains a reasonably standard type—which is not always the case. When he fails to do so examination usually shows that he is trying to make the best of both worlds, milk and beef, according as the market fluctuates from year to year. And yearly fluctuations can never form the basis for the selection of animals with an average generation rate of five to six years.

There is justification for extreme types of dual-purpose animals on the ground that it is the first cross that often makes the best commercial animal. This is almost invariably true as regards meat production. Following this argument further the dual-purpose cow crossed to a bull of a good beef breed produces a steer of definitely good quality. Heifers from such a cross should not be kept for breeding however good their looks. It is failure to appreciate this fact that has given the dual-purpose critics some considerable justification.

This brings up the general subject of cross-breeding. So far experience—but practically no experiment—has shown that the first cross between dairy breeds is not usually a commercial proposition. This is an interesting point, the investigation of which involves the fundamental facts of milk production. On the other hand, in certain circumstances, there are crosses which can with advantage be made between the dairy and dual-purpose breeds.

It has been customary to talk of this island as the stock-farm of the world. It is also customary to decry the multiplicity of our breeds of live stock. The market requirements of cattle at the present day are varied and there is no certainty of the future. The quickest way in which to adjust production is by the first cross. Hence there is every justification for our variety in breeds. We do not want to standardise too much, for the tastes of the consuming public are fickle, and such fickleness is the one certainty in the outlook. A hundred years hence to drink four per cent milk may be anathema.

But what we do require is knowledge, so that the breeder may the more quickly adjust his requirements both to changing economic conditions and to alterations in the taste of the public.

GRASS AND MONEY

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THERE are two movements in modern British farming working out of harmony with each other instead of in harmony. The number of cattle in the country has grown in the last forty years, especially the number of cows. The area of good grass which should serve as their chief source of food has diminished. Farmers can cultivate their grassland, which it is their duty and interest to do, and produce the best food for their stock, or they can become cow-feeders, users to a greater extent of cake and meal, convenient but more expensive food.

In 1894, there were in Great Britain 6,347,113 cattle of every description; in 1934 the number had grown to 7,973,351, an increase of 1,626,238. In the first year there were 2,460,086 cows and heifers in milk or in calf; in the second there were 3,491,388, an increase of 1,031,302. Sheep had fallen from 25,861,500 in 1894 to 24,182,578 in 1934, but the heaviest demand for food is made by cows in milk, the class in which there has been the greatest increase.

While on this side the demand for grass has been going forward, on the other the supply of grass has been going back. Professor Stapledon, in a paper read to the Royal Society of Arts in May, 1936, dealt with this. " There are," he said, " in England and Wales 15½ million acres of permanent grass; over 2¼ million acres of leys, and nearly 4½ million acres in rough and hill grazings below 1,500 feet. Let us be quite conservative and assume that no more than one-twentieth of the leys are outrun and hopelessly unproductive, and that only 20 per cent of the rough and hill grazings below 1,500 feet are even amenable to improvement. . . . At the other end of the scale, I am not prepared to admit that there are over 300,000 acres of permanent grass in England and Wales that are as grassland fully productive and of the highest class. I know for a fact, as the result of a detailed survey, that of the 2¼ million acres of permanent grass in Wales, only about 36,000 acres can fairly be classed as even tolerably good ryegrass pastures.

" On the basis of these figures for England and Wales, we are faced with the astounding fact that in round numbers we have 16¼ million acres of land in a more or less neglected condition, and much of it absolutely derelict; and what is more, every single acre of this enormous area, no less than 43 per cent of the land surface of England and Wales, is capable of radical improvement."

This is a review of the condition of grass by a botanist who has had the means of making careful investigation over a long period. A similar survey by a chemist would reveal corresponding defects from his point of view. And what is out of joint in their spheres is defective in similar proportion in the economist's. There is a positive loss of money in keeping grassland in such a state of cultivation that what is obtained from it is less by varying amounts than what must be paid in respect of it. There is a reprehensible failure to make money when the return from investment in its cultivation is not of a substantial nature. Professor Stapledon's statement is a very strong and far-reaching criticism of English and Welsh farming. It will find support in the convictions of observant farmers and of observers with an eye for what is good, middling and bad in farming. No similar review seems to have been made of conditions in Scotland, but the proportion of grassland belonging to the classes " neglected," " derelict " and " capable of radical improvement " does not differ seriously from that in the other two countries. There are the areas laid out in ridges, " rigs," some fenced, some unfenced, which were at one time under the plough. Some of these may have been exhausted by the last cultivated crops, and laid down in a hungry condition. They suffer sheer poverty, and grow little. Others may grow an abundance of grass of a quality so poor that cattle and sheep leave it ungrazed, or the cattle are not there to graze it. The growth of one year dies down and proves a hindrance to the growth of the next. To be the responsible occupier of land of this kind is to suffer financial loss. Whether it is rent, or interest on capital value, or other standing charges associated with its tenure, the return from such land, under its progressive deterioration, becomes less capable of meeting these. And nothing will reduce or stop the loss except a reversal of this process. When farmers give up making active demands on their land, when they cease to stir it into activity with the plough, or with efficient substitutes, when they fail to give food to the soil which it passes on to the plants, which they pass on to the animals, and which they in turn pass on to the farmers, a state of inactivity is created which is as unprofitable as inactivity is everywhere.

A variety of circumstances has contributed to produce the present situation. Grass has always suffered from neglect. It has always been kept in the second, third or fourth place in the company of other crops, as well as being considered a crop which is not entitled to any respect or attention at all. There have been intelligent but mostly isolated protests against this treatment. One such may be recalled, because it was made by a Scotsman. In 1831 Mr John Boswell, laird of Balmuto, Fifeshire, wrote an article in the *Quarterly Journal of Agriculture* " On the Unprofitableness of Old Pasture compared with New." He had watched the behaviour of cattle and sheep, and noticed their preference for new grass when both old and new were open to them; the new came earlier and grew more rapidly than the old; he remarked on the importance of palatability, and emphasised the increased value in terms of rent. His conclusion was that, " except a few favoured spots, no ground can, without loss, be left long in pasture; that it appears to me, four or five years is, generally speaking, the longest period land should be allowed to lie in grass."

The subject of grass cultivation has invited the attention of farmers with increasing force, and now and then some one acknowledges and emphasises the importance of seed mixtures, and the importance of fertilisers. Their laborious research has maintained an interest in the subject, but an interest of a less than half effective kind., Something more is needed. Without disparagement of corn crops, potatoes or roots, the time has come when the place assigned to grass among these crops should be reconsidered. Whether the rotation is three-course, four-course, or five-course, grass invariably gets the second or third beneficial share of cultivation, and generally the third or fourth of fertilisers. When this system was adopted home-grown wheat was a prime element of human food, and was rightly given first place. The market and price for it may have justified this. However that may be, things have altered. Better wheat can be grown in other countries, but the people of Great Britain who care for these things will cherish the conviction that their island has not been surpassed as the place where grass in quality and bulk can be produced, and the determination that it will not be surpassed.

One of the first things to do is to contemplate the abolition of the " nurse " crop. For reasons which are obvious this misnomer was used to describe the corn crop with which the grass and clover were sown. A nurse should be, and generally is, unselfish and generous towards her young charge. She would not deprive it of food and air, starve and smother it. The " nurse " crop will do both with less or more thoroughness. Let grass be brought forward to the first place, let farmers plough, harrow, prepare a good tilth straight for grass, let them use lime, phosphates, potash and nitrogen in generous quantities. Why? It will pay them. Soils and grass and cows and bullocks and sheep and a profit are all things which deserve to be treated with the utmost respect by British farmers. But if they fail in their respect for one, they fail in their respect for all.

To demonstrate that this attitude and this method of working are profitable enough to justify their adoption, figures are given to show the results from their use on a Lancashire farm in the summer of 1936. The farm, which lies far from a main road, extends to 105 acres, about 5 of which are occupied by old marl pits and wooded banks. The soil is nearly all a cold grey clay on top of coal. There are a few depressions in which peat is found and a few patches of gravel. The best features of the place are that it is level, the fields a useful size, and the buildings well situated. The farmer came to it in 1921, a young man with not too much capital. The farm was under a rotation of potatoes and roots, corn, hay and grass. It had been exhausted. But he was determined to have a farm, and they were hard to get. The rent is 25s. per acre. He kept the plough going, used lime and the standard quantities of other fertilisers in the rotation, and made a steady improvement. He lost seriously on poultry, and made little on his crops. This sent him over more heavily to cows and milk. He had conceived no dislike of the plough, and when the question of ploughing for grass arose, he ploughed for grass as much as a matter of course as if it were ploughing for potatoes. In 1935 he decided to put the theory of a comparatively full cultivation, and a comparatively generous supply of plant food, for grass to the test. A field of 8 acres, No. 1 in the following table, was sown straight to grass late in the spring of 1935, with an approach to the cultivation which would be considered reasonable for oats. It had been in kale the year before. The weather was cold and dry, and the seeds had a difficult start. Grazing began about the end of July, 1935, and has continued winter and summer since that time. During the winter of 1935-36, 80 tons of low-grade slag were applied to 80 acres, mostly for grass but some for hay. This was followed by 1 to 6 cwt. of nitro-chalk per acre.

One object in giving the heavy dressing of phosphates in the form of slag was to arrest the deterioration in the rye-grass and clover mixtures, to reverse this movement, and bring the land into good heart. The only field in this condition is No. 2 in the following table. It is a small convenient field next to the house, and had been used to graze stock which were receiving cake at the same time. In addition, it had been limed and received other fertilisers. The farmer described the position when he said that it illustrated the occurrence of "cumulative fertility" while the others were fair examples of "cumulative starvation." The strongest and final reason for applying the generous quantity of phosphates is that the farmer intends to make his soil work hard. He is convinced that grass is the cheapest and best food for cows, and he is going to get as much of it as possible. He is going to increase the activity of the soil by the generous use of nitrogen, and by ploughing, and he intends to make sure that he does not rob it of the phosphates, potash and calcium necessary to run it at this high speed. He would much rather have reserves of these in the soil than have even the risk of deficiencies. Why? Because it pays far better.

The following table shows the performance of the different fields:—

Field No.	Acreage	Management	Grazing 1936 First day—Last day	Gallons of Milk per acre
1	7·9	Grass sown May 1935. Grazed from July, 1935.	April 22—Aug. 5.	346
2	5·9	Grass seven years old next house and in good heart.	April 30—July 31.	245
3	14·1	Grass, one-half two years old, one-half three years.	May 2—July 30.	225
4	13·25	Grass three years old.	May 10—Aug. 3.	190
5	9·2	Grass four years old. Had lost root and quality.	April 26—July 15.	156

Taking April 22 as the date on which the competition between the fields started, field No. 1 was growing for 15 weeks, No. 2 for 14 weeks and 2 days, No. 3 for 14 weeks and 1 day, No. 4 for 14 weeks and 5 days, and No. 5 for 12 weeks. The difference in the rate at which the fields worked is shown by the grazing days provided by Nos. 1 and 5. The smaller field, No. 1, gave 22½ days' grazing, while the larger field, No. 5, gave only 12 days' grazing in the period, and gave only ½ day more until October 4. These five fields extending to 50·3 acres were the sole grazing of 70 cows in milk from April 22 to July 8. In addition, over the 15 weeks they had an allowance of 1·89 lb. of beet pulp and meal per cow per day, partly to keep them contented at milking time. The cost of this was 11s. 6½d. per cow for the period.

On July 8 a field of 13 acres was brought into use. The grass on this field was sown half about the middle of April, and half early in May, 1936. The first half was not well cultivated with the harrow; the second half, which was at first intended for kale, was thoroughly broken up with the disc harrow, and the grass seed fell heir to a comparatively fine tilth. The grass crop on the second half speedily overtook and passed that on the first, the growth being far closer, stronger and perfectly uniform. Both improved rapidly under the hard grazing and heavy treading of the cows, but in November the better-cultivated portion looked much superior. The performance of this field from July 8 to October 6, a period of 13 weeks, was 231 gallons per acre. On every occasion when the cows were brought on to it from others, the milk yield rose. The farmer said it had a feeding value in July and August equal to that of good ordinary pastures in May and June. He would make young grass like this take the place of oats and vetches when older grass is going off. Grass is more valuable early in spring, and late in autumn, than it is in May and June.

The comparison between the performances of the first five fields has been discontinued at August 5. Aftermath, or hay stubble, was brought in then, and a few days later a stock of 28 dry cows and young beasts and 2 horses was put on to field No. 1 to graze it down hard. The conversion of what they consumed into terms of gallons of milk would introduce complications and give results open to question, and has not been attempted. The careful recording of the milk yield from the different fields has provided a direct and trustworthy means of measurement. Management may be adjusted to make it possible to prolong the direct comparison of performances, but it has been decided to keep the character of the evidence here distinct and unqualified.

The costs and financial returns per acre are given in the following table. The returns in Column 3 are arrived at by the starch equivalent formula.

Field No.	Cost per acre			Returns per acre			Interest on cost
	£	s.	d.	£	s.	d.	Per cent
1	4	11	7	8	1	2	76
2	3	8	7	5	14	10	67½
3	3	10	0	5	6	1	51½
4	3	2	4	4	7	3	40
5	3	17	4	3	13	6	–5
6	3	15	8	—			—

In the costs cultivations and seeds are given a life of seven years and lime a life of six years.

Some notes about the condition of the fields are necessary. All of them except No. 4 had about 1 ton of low-grade slag to the acre in the winter, 1935-36. No. 6 had only 1 cwt. of nitro-chalk. Although there are 8 acres in No. 1, two of these on the peat, a belt of which runs through it, were never properly grazed, even when 30 dry stock were held on it for twelve days. Acidity, or some other condition, made the grass so unpalatable that they avoided it. Field No. 6 was the worst field in 1935 as No. 5 was in 1936. Sorrel and yarr were the chief crop on about one-third of its area, and this was limed. Bent was the most common crop on the rest and the whole was matted. The returns per acre from this field are not given, because the ration of meal was increased in September, and no separate record was kept of the amounts fed simultaneously with the grazing. The increase in yield while the cows were on this field was so great that it was considered worth while to reduce the meal ration, but the amounts of the reduction were not recorded. It should be added that Express Italian rye-grass is used in the seed mixture to give the quickest growth, and that indigenous perennial is used for permanent purposes. In criticism it may be said that 70 cows on 50 acres was too heavy a stock. The farmer would admit this, and intends to alter it by bringing in fields next summer which have been added to his farm. It is hoped that all the fields will soon be brought into good heart, and that cows in milk will be able to graze them without break for six or seven more weeks, and provide a proportionately wider basis for direct comparison.

An occasional fear was entertained by the farmer that he was not treating his grass as he should. He visited two or three farms one day where the pace was a little slower than his, where the stock was lighter, and where he saw rich crops of clover and grass, crops which would make better subjects in a photograph than his. For a short time he was depressed, but soon recovered his confidence and courage by reflecting that the proper place to judge grass, to admire or decry it, was not in the field, but in the milk or beef into which it was transformed. Grass should hardly be in the field long enough to become the object of admiration. However much he punished it by repeated close grazing it has come again under the driving force of abundant plant food.

For a different kind of evidence on this subject a return may be made to the comparison of the costs of producing milk from grass and from purchased food-stuffs. There are in Lancashire men paying rents from 20s. to 62s. per acre for land from which they get less than 5s. worth of food for their cows. They keep cows which give milk and which must be fed to do it. The failure of their fields is made good by resort to cake and meal, and the cost of milk to them is loaded with the unnecessary double burden of the difference between what they pay for their grass and what they get from it, and by the difference in the cost of the feed obtained from cake and meal and the cost of feed obtained from reasonably cultivated grass. There are farms in different parts of England where the cost of 1 lb. of starch equivalent from grass varies from ·25d. to ·28d. The lowest cost from cake and meal is ·80d. From the latest returns the average cost from grass on a group of farms in Dorset is ·41d., and from cake and meal 1·01d.; in the Midlands they are ·54d., and 1·06d.; in Lancashire and Cheshire they are ·73d., and 1·02d. More comprehensive figures come from the West of England, the Bristol area. For 41 farms out of a group of 133 for which records were kept, the cost of 1 lb. of starch equivalent obtained from grass between October 1 and March 31 was ·28d., as compared with 1·09d. for that obtained from concentrates. From a careful investigation of management and returns on different farms reasonably good farming with the use of harrows, fertilisers and clover seed should produce grass at ·4d. per lb. of starch equivalent. There are four farms in the group of twenty in Lancashire and Cheshire on which the cost of feeding from grass exceeds that from purchased food. They are small farms and the pastures are in three cases still in poor condition and all of them are seriously overstocked until the meadows are opened for grazing after hay-time.

Evidence of another kind of the value of well-cultivated grass comes from the experience of arable farmers in West Lancashire. Until four or five years ago they had never thought of using their peat and sand soils to feed bullocks. They knew that these light soils could grow very heavy crops of potatoes. They believed, as their ancestors had taught them, that they would starve bullocks, that they were too weak and silly to do anything else. But in recent winters a group of farmers have made a successful experiment with hundreds of fattening cattle. The basis of the enterprise is a generous dressing of low-grade slag with a high percentage of lime in substitution for lime, or in addition to it, followed by nitro-chalk and potash, lime always being given a prominent place. Unconsciously these farmers are suggesting, if they are not demonstrating, that almost any kind of soil will serve as a medium through which food can be conveyed to grass, and through grass to bullocks, cows and sheep. The soils here have always been kept open by the plough, and of themselves they keep open longer than others.

The experiment on a 95-acre farm may be taken to illustrate the enterprise. The first grass ever used by this farmer for grazing cattle was sown in the corn crop in 1932 in a field of 11½ acres. He had never even owned a cow, but in August 1933 after a hay crop had been taken 12 bullocks were bought and put on the young grass. This grew them well till the beginning of December. They were then given cake, straw and chat potatoes in a shed which was open to the field. They were sold in spring and early summer of 1934, and left a profit which surprised its recipient. In August of that year 18 bullocks were bought. A thrifty system well known in Scotland was adopted. Rye-grass and clover were sown in all the corn crops. This mixture in the stubble was grazed from harvest until it was ploughed down towards the end of the year. The bullocks were managed as the first lot were. Cost accounts showed that they left a profit many times as large as the yield generally obtained from investment in shares on the Stock Exchange.

This experience made the farmer bolder. The three-year-old grass and clover had improved enormously. In the autumn of 1935 and spring of 1936 he bought 45 bullocks. They left a profit of only a few per cent less than those of the previous year. With the narrow basis of 11½ acres of grass which have worked very hard 47 bullocks are now being fattened. As a potato-grower, who had probably grown them too often on the same fields, this farmer had his eye on the threat of the eelworm. He had taken it so seriously in August, 1936, that he allowed himself to contemplate a complete change over from potatoes to grass farming and bullock-feeding. There was and is no need for this revolution, but it was significant that a man, who had never bought a beast until three years ago, had discovered in this experience a way of escape from threatened loss on a system of cropping entirely different.

A digression from the discussion of English experiences may be made, and the attention of Scotsmen may be called to a demonstration on this subject in their own country as good as can be found anywhere. Soils and farming conditions generally on the Ayrshire coast and in West Lancashire are similar. The argument of this article could rest on no sounder basis than on the experiment in grass farming conducted in Ayrshire for many years. At Girvan early potatoes are lifted in late June and early July. Rye-grass is sown on light sandy soil into which abundance of organic manure has been put for two generations, and which receives generous supplies of mineral fertilisers. The tilth is perfect. In eight or nine weeks lambs are put on to the grass, a vast number per acre, and before the end of the year they are mostly turned into money. The rate at which this land works is unusually high, and the returns exceptionally quick. But it is grass which plays a lively and fundamental part in this combination of activities. It would hardly be thought that every soil and climate would move so quickly as this, but in view of the performance of the cold clay in an exposed part of Lancashire in 1935 and 1936 it might be wise to suspend judgment on this point.

Still another kind of evidence is available to illustrate what is happening on this side of farming. In little over a year within a comparatively small area of Lancashire five farmers, all of whom have experimented in improvement and recorded the results, have been offered and have taken farms—in one case part of a farm—adjoining their own on lease or purchase. The owner of one of these, who took possession in August 1935, writes on September 20, 1936: "The new farm is coming on wonderfully in my opinion, and would look cheap at £20 an acre, and not £7 as it stands me at." There are two points in this statement which will appear remarkable. First of all, there is the low price at which the farm was bought in 1935, and next the value of the improvement made in a year's time. To have farms close to good markets sold at £7 proves that they are derelict, and all those five farms would come into Professor Stapledon's derelict class. The farmers had persevered in starving them, the fields, as invariably happens in such cases, had reciprocated and starved the farmers. The next point is the rapid rate at which the farmer had increased the value by something approaching threefold. Two-thirds of the farm was arable, and one-third was matted pasture. All of it except one pasture received a moderate dressing of lime and 1 ton of low-grade slag to the acre. It was all sour, and the pasture was seriously matted. A disc harrow was put on to punish it all severely. Clover was sown on the pasture and a seed mixture on what had been ploughed. The progressive change was as remarkable as the farmer's figures suggest. The ugly brown patches of sorrel and naked soil had been covered by the young seeds, and in the mat which had been cut up the clover had taken root to a surprising extent. There was in the young fresh grass which had come an appearance of health, and of capacity for growth, which made the fields " look cheap at £20 an acre."

There are some general considerations which reinforce the arguments of these particular cases. In the evolution of things the cultivation of grass has become the element in British agriculture which deserves the most serious consideration of men responsible for the management of land. The area under grass is large and increasing. Unfortunately the change from other crops to this has been associated with the withdrawal of capital from cultivation, and with what is a sort of progressive economic paralysis. There is something fatal and utterly depressing in this situation where men have acquired the habit of acting as if the saving of money was the best way to make money, where there is no keen and restless search for opportunities to invest, no drive and thrust of enterprise. Men with all the materials in their hands for the conduct of an aggressive and successful business let them lie unused. Capital of their own which they might manage and direct with great advantage they hand to the managers of other businesses, lead a duller life, and draw far less interest on their investments.

There are, of course, alternatives to good grass farming for every occupant of a grass farm. Wintering and summering can be had away from home at a price. Cake and meal can be had, also at a price. But no matter how completely a farmer may be wrapped up in the assurance that these are the best methods, it is worth his while to ask how far good grass farming would not be more profitable. Heavy wintering costs are necessary in many cases, but probably not so heavy if more was made of the home grassland. There has been some commendable enterprise in establishing a soya-bean mill in Glasgow. It will place good imported produce at the service of stock-feeders, and the length of our winters will guarantee a market for what it grinds. But the grass mills in the fields in their possession have the first claim on farmers. They owe it to themselves, and they owe it to the country of which they are a responsible and important section, to reduce their costs of production, and it is in their fields that they can do this. A climate unfavourable to the ripening and harvesting of grain crops is not unfavourable to the growing and grazing of good grass. The meal-feeding season should be cut short at both ends, in spring and autumn. Grass fields are factories for the manufacture of the cheapest and best food for cattle and sheep, and the better they are run the better they pay.

The half-begun, or half-finished, process of investment in grass-growing is the serious flaw in this great business. Farmers pay rent or a price for their land together with certain inevitable standing charges. Fertilisers, cultivation, seed and proper grazing call for payments. These calls should be respected for reasons which govern every economic enterprise. The first instalment must be backed up by a second, third and fourth instalment to make its working complete and fruitful. To stop at the first is to throw away money; to stop short of the last is to lose profit. Nothing will establish British agriculture on such a sound basis as the use of the plough for the growth of grass. Without it the machine under the farmers' control cannot be run fast enough to secure the highest profit. For the quick and effective introduction into the soil of raw materials from which grass is made, and for its speedy production in finished form, the plough is necessary. A wise driver will not run his four-cylinder car on three cylinders, still less on two or on one. Grass farmers try hard with one.

Among the most worthy and most formidable rivals of home farmers in this work are their kinsmen in New Zealand. Necessity has made them serious experimenters, and this discussion of how to make money may close with a glance at their methods and aims. In 1935 the Dairy Industry Commission published a report on conditions in the Dominion. They gave certain figures showing the financial results of using fertilisers on grass. The information was obtained by the Department of Agriculture from 550 farms in the North Island, and the following is a summary of the results*:—

Butterfat Production per acre lb.	Expenditure on Fertilisers per acre s.	d.	Cost of Fertilisers per lb of Butterfat d.
Under 75	5	8	1·193
125—150	10	9	0·943
200—225	14	8	0·839
250 and over	18	10	0·803

These figures illustrate clearly the principles governing investment. There are bigger prizes than these to be won in grass farming in Great Britain.

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* *New Zealand Jour. Agric.* vol. 50, p. 369 (June 1935).

CLEANING DIRTY LAND TO PRODUCE SOIL FERTILITY

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FAR too much of our farm and garden land is polluted with perennial weeds. Some observers go so far as to say that Scottish agriculture at the present time falls short of the pre-war standard. It is unnecessary to discuss the causes since these are well known, but the problem requires to be solved and the experience of some years' experimental work on a field scale may be of interest. The results have been so successful that experienced farmers who have examined the fields have expressed their astonishment. The plan now described was attained only after a considerable amount of trial and error. The study of such literature as could be found bearing on the subject led to the work of American scientists who have been endeavouring to solve the problem of the lack of humus over great areas in that country. Their methods provided some useful ideas but did not prove satisfactory for Scottish conditions. The opportunity of dealing seriously with the problem occurred when the necessity arose of cleaning some long uncultivated but good land.

In the earlier experimental stages sodium chlorate was used, but it was soon proved that the best results could not be obtained from the use of that chemical without the combination of proper cultivation. All chemical treatment must indeed be accompanied by cultivation. The usefulness of sodium chlorate and the method of application have already been fully described.

Sodium Chlorate plus Green Manuring.—This method, which works very well, requires a full season to deal with very dirty, weedy land, and is based upon results obtained from using sodium chlorate alone. The land should be ploughed in winter or early spring. Sodium chlorate should be applied at the rate of 1½ cwt. per acre not later than early April. The growth of all weeds and especially of couch grass will be very much reduced, but by mid-July these appear to take hold again. The land should then be ploughed again and sown with white mustard, 28 lb. per acre, which is ploughed under after rolling, and before seeds form in the pods in September.

Ploughing once more in winter and again in spring before planting potatoes, cabbages, turnips or any other green crop, ensures that little work is required to secure a clean soil containing a moderate amount of humus. The chlorate destroys the roots of weeds so that these in the main disappear and the humus is derived from the green stuff, either weeds or mustard, that has been ploughed under. This method is not suitable where land is affected with finger and toe. Owing to the cost of the chlorate it is rather expensive, although in certain circumstances it has been proved to be a very useful and practical plan.

Green Manuring and Calcium Cyanamide.—This has proved to be by far the most practical method and the one productive of the maximum amount of valuable food material for the growth of crops.

This plan does not employ any poisonous material and adds exceedingly to the fertility of the soil. It occupies a whole season, but all the work may be undertaken at convenient times and does not hinder the usual farm work. It can be used on extremely weedy and neglected land with complete success so long as it is fairly well drained.

The land should be ploughed during the winter or early spring and sown with tares at the rate of 1½ cwt. per acre in February or early March. When these come to their first flower in late June they should be mushed up with any heavy implement and 3 to 4 cwt. of calcium cyanamide should be applied per acre to begin the process of fermentation. The best results are obtained by applying the cyanamide in the early morning when the dew is on the tares. It should be left for six to eight days before ploughing under. Plain rolling coulters, not discs, are necessary to cut the great mass of material to allow of proper covering. The surface should be prepared and rye sown at the rate of 2 bushels per acre, not later than the third week of July. This produces a vast root system and a thick mat of green stuff to be ploughed under from October to December. By ploughing again immediately before planting potatoes or putting in another green crop in April and pursuing the ordinary cultivation afterwards the couch grass and other perennial weeds are completely destroyed and converted into humus. It is advisable to apply phosphates and potash to the potato crop since the treatment described above will have provided an excess of nitrogenous food material.

It has always been recognised that leguminous crops such as tares enrich the soil with nitrogen collected by the bacteria within the nodules on the roots. It is therefore remarkable that immediately the tares are ploughed in the soil seems to be deficient in nitrogen for some considerable time. By using cyanamide, however, a certain amount of nitrogen is made available to start the rye.

The land is now ready to grow any crop successfully but preferably potatoes, sugar beet, cabbage, turnips, mangolds or silage prior to cereals, in order to utilise the accumulated humus economically. The root system of tares and rye provides a much larger proportion of humus than is generally supposed, and these plants were therefore chosen in preference to many others. White mustard, for instance, has a very poor root system.

The application of calcium cyanamide to start the process of fermentation is a vital factor. No other agent yet tried has proved even moderately successful. It is possible that other chemical agents may be found, and this is an opportunity for an enterprising research worker.

A complete explanation of the scientific processes involved in this method and the varied reactions taking place in the soil is not attempted here and would be extremely difficult, but the results are so encouraging as to indicate that the plan may be applied to very dirty land with a guarantee of success. Farmers may use it with great advantage and many may be able to improve upon it. Some part of the strongly-growing tares or rye may possibly be utilised for grazing purposes or silage but this requires testing, since it may not work out so well for the ultimate fertility of the soil.

Approximate comparative costs " on paper " of the two methods are given below, but the actual cost is very much less when the farmer takes into consideration that a " saleable " crop (such as oats) may show a cash loss and that regular farm labour involves a standing charge which must be met whatever amount of work is accomplished in the course of the year.

1. *Sodium Chlorate plus Green Manuring*

	Per acre
Ploughing very dirty land	£1 10 0
1½ cwt. sodium chlorate at 36s. . .	2 14 0
Ploughing in July	1 0 0
28 lb. mustard	0 10 0
Preparing land and sowing . . .	0 10 0
Ploughing mustard under . . .	1 10 0
Ploughing in winter	1 0 0
Ploughing in spring	1 0 0
Rent	3 0 0
Total . .	£12 14 0

2. *Green Manuring and Calcium Cyanamide*

	Per acre
Ploughing very dirty land	£1 10 0
1½ cwt. tares at 18s.	1 7 0
Sowing, harrowing, etc.	0 10 0
3 cwt. cyanamide at 7s. 6d. . . .	1 2 6
Ploughing tares under	1 5 0
2 bush. rye	0 15 0
Sowing, harrowing, etc.	0 10 0
Ploughing rye under	1 0 0
Ploughing in spring	1 0 0
Rent	3 0 0
Total . .	£11 19 6

It is impossible to apply a good dressing of dung for less money per acre and while it may be argued that land so treated is not producing a crop for sale—can dirty land ever produce a profitable crop?

The costs given may be adjusted according to the rent and other factors. One good feature is that there is no interference with the usual routine of farm work. The tares are sown before oats and ploughed down in July after haymaking or in a wet spell during haymaking, while all the other work connected with the process can be accomplished when ample time is available. The method may be included in the rotation with ease and provides an alternative to farmyard manure which can only be produced very expensively through the feeding of cattle.

Trial has proved that one green manuring crop, particularly if taken as a catch crop, yields rather poor results although it is better than leaving the land idle to suffer from washing out. Bare fallowing is practically useless in Scotland. It is important, whenever possible, to plough under green manuring crops when they are wet. When such a crop is ploughed under in dry conditions without cyanamide to promote fermentation the tendency is to form a dry strawy layer which dries out the surface soil to such an extent that any crop put in immediately after is a failure. When the layer does decay hollow spaces are left which are very bad for the growth of many crops. This very practical and common difficulty is surmounted by the use of cyanamide, but even with it the best results are obtained when wet weather occurs at the time the crop is ploughed under.

Some critics say that a whole year given over to this plan means a crop lost, but many successive crops are lost on very dirty land and prove very costly in hand labour. No hand labour is necessary and farmers who own tractors can utilise these for the work at a time of year when normally these machines would be idle. The plan provides a solution for those farmers who now operate on a large scale but have not been able to provide sufficient humus to maintain soil fertility. In any case the total destruction of couch grass, dockens, and other perennial weeds is certain. The remains of such weeds last longer in the soil than do the remains of the tares or rye and thus form a valuable source of slowly-decomposing humus which gives back to the land all that had been extracted during the growth of the weeds. The soil after a potato crop is taken appears and feels like good, rich, potting soil, full of life and in a physical condition seldom achieved by ordinary cultivation. Very little loss occurs by washing out since a crop is almost continuously on the land from March to December, and the accumulated humus appears to hold the food material.

Reference is made to Professor Hendrick's paper published in the October issue of this *Journal*, particularly to his remarks about soil fertility and the value of humus. As everyone knows, there is now great difficulty in securing an adequate supply of good dung except through the feeding of cattle. Supplies obtained from town dairies, stables, and piggeries are diminishing and appear to be less valuable than they were. It is not possible for every farmer and grower to keep cattle and all cultivators of the land are forced to adopt methods to produce the best substitute for dung, which is humus, since true soil fertility can never be supplied by chemical fertilisers alone. The object of the plan here described is to build up a humus content in the soil.

Green manuring has been known and practised from very early times, but so far as can be ascertained it has not been combined with the application of any material or agent to promote decomposition. Experiments conducted for a period of five years have proved that such an agent is necessary.

The plan may be recommended to landlords left with very dirty land on their farms, which can thus be put right within a very short time.

Very weedy gardens can be reconditioned by operating on one-fourth to one-third per annum until the whole is accomplished. Land hitherto thought inaccessible owing to distance or slope may now be successfully reconditioned. The healthy, natural growth of any crop after such reconditioning brings within the range of possibility the cropping of isolated land to promote the growth of extra healthy stocks of potatoes or strawberries for propagation in more highly cultivated ground. There is some possibility of utilising the plan in the tropics to provide humus for tea and coffee plantations in a manner not requiring the transport and hand labour connected with the " Indore " system.

The health as well as the fertility of the soil is promoted and there are indications of the possibility of furthering by this method the effective control of some of the numerous pests infesting highly-cultivated land.

The calcium cyanamide used in these experiments was the powdered form and it is not yet known whether the more convenient granular form would act so efficiently. In other experimental work on the destruction of annual weeds, however, the granular has proved as effective as the powdered form except that it takes longer to act.

The soil in the field where last year's experiment was carried out varies from very light to very heavy owing to the presence of various outcrops. Evidence is thus provided of the usefulness of the system for all classes of soil. The field is open for inspection by persons interested.

NOTE.—The article on " Labour Requirements on a Mechanised Wheat Farm," contributed to the October issue of the JOURNAL by Mr H. Whitby, was written while the author was a member of the staff of the Agricultural Economics Research Institute, Oxford.

SEED TESTING AND PLANT REGISTRATION

PART I—SEED TESTING STATION

Report for the period from 1st August 1935 to 31*st July* 1936

Samples of seeds to the number of 9,135 were received for testing, this number being an increase of 699 on the number received for the corresponding period in 1934-35. Traders' samples numbered 7,811.

The samples were tested in accordance with the provisions of the Seeds Act, 1920, and the Seeds (Scotland) Regulations, 1922, with the exception of 65 samples submitted by merchants for analyses in accordance with the seed laws governing the import of seed into the following countries:—Australia (28), Canada (6), France (4), Yugo-Slavia (12) and New Zealand (15). International Analyses Certificates were issued when requested. The total number of reports issued was 19,961.

Commercial Control.—Seed samples to the number of 389 were drawn by the Department's Officers. Approximately 8 per cent of these carried improper declarations.

Licensed Seed Testing Stations. — The premises of seven merchants holding licences to test seeds were visited for the inspection of their records of work. Samples numbering 206 were selected for official confirmation of tests, ten of which were found to be not strictly correct within the prescribed limits of latitude. Requests were made to the firms concerned to have re-tests carried out, and in each case the re-test agreed with the official test.

The undernoted table shows the distribution, according to the species, of the samples received, compared with similar data for the four preceding seasons.

[TABLE

NUMBER OF SAMPLES OF DIFFERENT KINDS OF SEEDS TESTED

	Season 1935-6	Season 1934-5	Season 1933-4	Season 1932-3	Season 1931-2
Cereals					
Wheat	685	673	651	625	351
Oats	1,360	1,425	1,187	1,494	1,930
Rye	17	17	20	21	30
Barley	194	140	298	88	147
	2,256	2,255	2,156	2,228	2,458
Forage					
Rape	46	38	36	35	31
Tares	41	34	40	52	36
Burnet	3	4	4	2	3
Ribgrass	19	20	20	18	25
Chicory	16	14	15	14	20
Yarrow	11	4	2	5	4
Sainfoin	2	...	...	...	...
	138	114	117	126	119
Roots and Vegetables					
Beet	82	62	73	45	63
Mangel	32	40	75	48	35
Turnip	341	373	403	366	360
Swede	342	337	338	278	250
Cabbage and Savoy ...	97	95	86	51	71
Kale and Borecole ...	75	61	51	34	19
Brussels Sprouts ..	20	16	25	15	14
Broccoli	19	19	15	10	12
Cauliflower	32	31	34	27	26
Carrot	110	87	136	94	116
Parsnip	24	15	26	16	28
Peas	104	128	108	92	100
Beans	59	54	56	54	64
Onion	79	84	89	86	93
Kohl Rabi	...	...	1	2	...
Brassica sp.	...	...	...	61	...
Miscellaneous	96	80	58	66	50
	1,512	1,482	1,574	1,345	1,301
Clovers					
Red	810	810	840	751	832
White	300	316	291	305	320
Wild White	357	332	407	370	385
Alsyke	200	171	224	197	253
Alsyke and White ...	51	34	24	18	27
Trefoil	57	55	58	65	64
Lucerne	3	1	...	2	2
Kidney Vetch ...	33	18	17	26	29
Miscellaneous	10	2	3	9	5
	1,821	1,739	1,864	1,743	1,917
Grasses					
Perennial	1,179	829	790	856	767
Italian	487	412	404	475	489
Perennial and Italian	77	57	23	41	49
Meadow Fescue ...	95	96	95	93	76
Timothy	486	380	357	306	319
Cocksfoot	526	548	557	534	513
Dogstail	82	59	54	93	85
Miscellaneous	355	377	375	333	347
	3,287	2,758	2,655	2,731	2,645
Linseed	4	2	...	3	1
Tree Seeds	107	62	38	28	24
Miscellaneous	10	22	10	4	9

STATISTICAL RESULTS, 1935-36

GRASSES

Variety	Number of samples	Purity			Germination			Percentage number of samples			Prescribed percentage standard of germination
		Highest	Lowest	Average	Highest	Lowest	Average	containing 2% or more of injurious weed seeds	below prescribed standard of purity (98%)	below prescribed standard of germination	
Perennial Ryegrass .	1179	99·9	78·9	98·3	99	49	91	2·1	22·3	5·7	85
Italian Ryegrass .	487	99·9	84·1	99·0	99	41	95	1·1	7·0	1·9	80
Mixture . . .	77	99·7	85·7	98·4	98	69	89	2·8	15·3	7·8	82
Meadow Fescue .	95	99·8	83·9	98·3	99	44	95	...	...	..	...
Cockstoot. . .	526	98·0	67·6	91·3	99	74	95	...	...	...	...
Timothy . . .	486	99·9	90·5	96·5	99	45	93	...	..	...	...
Dogstail . . .	82	99·8	66·6	97·1	99	63	94	...	...	...	...
Tall Oatgrass . .	16	94·9	88·9	92·9	93	70	83	..	...	...	...
Meadow Foxtail .	8	82·8	64·2	75·3	85	62	73	..	...	...	...
Rough Stalked Meadow Grass .	111	99·1	87·6	92·9	97	72	92	...	..	...	...
Smooth Stalked Meadow Grass .	35	95·3	81·9	89·0	91	70	83	...	...	...	...
Hard Fescue . .	30	97·8	78·2	91·7	98	79	90	...	...	..	...
Tall Fescue . .	39	99·6	11·4	93·4	98	76	92	...	...	...	...
Agrostis . . .	30	99·9	86·1	96·5	98	35	92	...	...	...	. .
Fine-leaved Fescue .	5	90·0	84·7	87·2	89	35	74	...	...	...	...
Chewings Fescue .	34	99·7	97·1	98·4	99	4	88	...	...	...	...
Red Fescue . .	16	98·8	82·8	90·1	99	78	90	...	...	...	...
Sheep's Fescue. .	1	. .	...	88·3	...	...	87	...	...	...	...
Mixed Poas . .	8	89·5	45·3	69·3	97	89	94	62·5	...	...	...
Poa memoralis. .	3	90·2	75·6	84·3	85	84	84	...	...	...	...
Holcus . . .	6	73·3	36·5	56·8	95	83	90	.	...	...	...
Aira flexuosa . .	1	...	...	81·7	...	...	79	..	...	...	...
Perennial Siftings .	4	...	...	...	...	...	...	...	..	..	...
Miscellaneous . .	10	.	...	...	...	...	...	...	...	...	...

Perennial Rye-grass.—The number of samples tested shows an increase of 350 over the number received in the previous season. The quality was on a par with that of last season. There was a decrease of 3 per cent in the average germination as compared with the average germination last season, but this year's averages of purity and germination show an increase of 0·8 per cent in purity and 5 per cent in germination when compared with the averages recorded in the past fourteen seasons.

Towards the end of the season, a few samples submitted as Irish-grown Perennial Rye-grass were found to contain an admixture of New Zealand seed. Altogether 112 samples were received as Evergreen Perennial, 87 of these being described as Kent Evergreen, 23 as Ayrshire Evergreen and 2 as Irish Evergreen. This is an increase of 48 on the number of Evergreen Perennial samples received during the previous season. Five samples of Danish-grown Perennial Rye-grass submitted denote Denmark as a recent entrant into the industry of producing seed of Perennial Rye-grass.

Italian Rye-grass.—The number of samples received shows an increase of 75 on that of 1934-35. The quality was identical with that of the previous season, and there was an increase of 0·7 per cent in purity and 6 per cent in germination on the averages of purity and germination recorded in the past fourteen years. There was a large increase in the number of samples of Danish-grown Italian, one-third approximately of the samples being of this origin. The seed was of high quality.

The following is a statement for the years 1929 to 1936 setting forth the average percentages of awned and unawned seed in samples derived from the three principal sources of Italian Rye-grass. It is of interest to note that French Italian Rye-grass contains the greatest percentage of awned seed, while seed imported from Denmark contains the least.

PROPORTIONS OF AWNED AND UNAWNED SEED

SEASON	IRISH		FRENCH		DANISH	
	Awned	Unawned	Awned	Unawned	Awned	Unawned
	%	%	%	%	%	%
1929-30 . .	59·9	38·8	82·3	16·2	...	...
1930-31 . .	72·3	26·7	82·0	16·2	...	...
1931-32 . .	73·9	25·3	88·0	10·9	...	...
1932-33 . .	75·4	23·3	82·7	16·3	57·8	41·3
1933-34 . .	71·2	28·1	81·7	17·3	58·3	40·7
1934-35 . .	75·3	24·1	84·9	13·9	54·3	44·7
1935-36 . .	73·7	25·7	82·2	17·3	51·3	48·1

Mixture.—There has been a steady increase in the number of samples of Mixture received during the past two or three seasons. The increase this season was 20 over that of last season. The average purity and germination were slightly lower than those of the previous season, the difference being 0·3 per cent in purity and 5 per cent in germination, but this year's averages show a great improvement on the average purity and germination recorded in the past fourteen seasons.

Meadow Fescue.—This season 85 per cent of the samples represented seed from Denmark, whereas last season most of the samples were of American origin. The average purity was practically the same as last season, while the average germination showed an increase of 2 per cent. This year's averages compare favourably with those of the past fourteen seasons.

Cocksfoot.—Seventy-five per cent of the samples represented seed imported from Denmark, while 10 per cent represented seed imported from Sweden and 10 per cent seed imported from New Zealand. The average purity and germination recorded were slightly higher than those of the previous season and 0·4 per cent in purity and 1 per cent in germination higher than the averages of the past fourteen seasons. Eight samples were described as Danish-grown Akaroa Cocksfoot and three as English-grown Akaroa Cocksfoot.

Timothy.—The number of samples received was 486, an increase of one-third on the number received the previous season. Approximately 70 per cent of the samples represented stocks grown in Scotland, chiefly in the Carse of Stirling, and 25 per cent represented seed imported from the United States. Only four of the samples received were of seed imported from Canada. The average purity was 2 per cent lower than the average last season, while the average germination was 1 per cent lower. Comparing this year's averages with those of the past fourteen seasons, the average purity is lower by 1·9 per cent while the average germination is the same. The decrease in the average purity is due to the increase in the number of samples received of Scottish-grown Timothy which usually contains a notable percentage of Dogstail and Agrostis.

Dogstail.—All the samples represented stocks grown in Ireland with the exception of one sample which was submitted as English-grown. This sample had a very low purity and depresses unduly the average, which is 0·9 per cent below that of last year's average and 0·8 per cent lower than the average purity of the past fourteen seasons. The average germination is 3 per cent higher than last year's average and 9 per cent higher than the average of the past fourteen seasons.

There is an increase of 529 samples of Grasses on the number submitted in 1934-35.

Statistical Results, 1935-36

CLOVERS

Variety	Number of samples	Purity			Germination			Percentage number of samples containing	
		Highest	Lowest	Average	Highest	Lowest	Average	1% or more of injurious weed seeds	2% or more of Suckling Clover
		%	%	%	%	%	%		
Red Clover	802	99·9	80·8	98·2	98+1	25+ 2	90+ 5	...	...
White Clover	299	99·8	80·5	97·7	98+1	58+40	89+ 6	...	...
Wild White Clover	357	99·8	78·4	97·7	98+2	51+48	87+10	...	4%
Alsyke Clover	200	99·8	83·3	96·9	99+1	61+ 9	91+ 5	...	...
Alsyke and White	51	98·7	92·8	96·4	96+1	65+ 8	81+ 8	...	...
Trefoil	57	99·9	98·4	99·5	97+0	74+ 3	91+ 2	...	...
Kidney Vetch	33	97·4	90·8	94·1	94+3	76+11	86+ 7	...	...

Red Clover.—The average purity of samples was identical with that of the previous season while the average germination was 2 per cent less. Comparing the average purity and germination with the averages of the past fourteen seasons, this year's average purity was 0·3 per cent higher while the average germination was 1 per cent higher.

Approximately 65 per cent of the samples were of the Broad-leaved type and the majority of these were of English origin; next in importance was seed from Chile. The remaining 35 per cent were of the Late-flowering type. Approximately two-thirds of these represented seed harvested in England, slightly less than one-third being from Montgomeryshire. The remainder represented imports from the United States and Sweden.

Slight traces of Chalcid Fly were found in 50 per cent of the samples described as American while of Canadian samples 70·3 per cent were found to have a trace.

White Clover.—The average purity and average germination of this seed were practically the same as those of the previous season. The average purity showed an increase of 0·9 per cent on the averages of the past fourteen seasons, while the average germination was identical. Fifty-five per cent of the samples represented seed imported from Poland, 31 per cent seed imported from New Zealand and 10 per cent seed harvested in England. The remaining 4 per cent represented seed imported from Denmark, Hungary and Czecho Slovakia.

It was found that 11 per cent of the New Zealand samples and 13·7 per cent of the Polish samples appeared to exhibit traces of *Sclerotinia Trifoliorum*, var. *minor*.

Wild White Clover.—The total of 357 samples of this seed shows an increase of 25 on the number received in the previous season. The average purity and germination were 0·6 per cent and 1 per cent respectively lower than the averages of the previous season, but comparing this year's averages and the averages of the past fourteen seasons, there was an increase of 1·3 per cent in purity and 4 per cent in germination.

From laboratory examinations of the seed on the samples submitted, it was found that all the samples were genuine or practically genuine. Only four samples were submitted by Seed Merchants for test of certified Wild White Clover. Eighteen samples were received from the Cambridge Station representing 11 Grade A stocks and 7 Grade B stocks, certified by the Ministry of Agriculture and Fisheries. Portions of these samples were sown out for field trial.

Alsyke Clover.—All the samples with the exception of three were imported from Canada and the United States. The average purity was 0·9 per cent less and the average germination 1 per cent higher than the averages for the previous season.

Alsyke and White Clover.—Approximately two-thirds of the samples represented imports from Europe, chiefly Poland, the remainder being of Canadian origin. The average purity and germination were slightly lower than in the previous season and they were also slightly lower than the averages of the past fourteen seasons.

Trefoil.—All the samples represented stocks grown in England. The average purity and average germination were practically the same as last season.

Kidney Vetch.—All the samples, which were double the number submitted the previous year, represented stocks imported from Europe. The average purity and germination were similar to that of the previous season.

The samples of Clovers received this season showed an increase of 82 on the number received in the previous season.

Dodder Tests.—158 samples were submitted for dodder test, viz., Red Clover 44; White Clover 37; Wild White Clover 30; Alsyke Clover 14; Alsyke and White Clover 25; Trefoil 2; Kidney Vetch 4; Sweet Clover 1; Lotus villosus 1.

STATISTICAL RESULTS, 1935-36

CEREALS

Variety	Number of samples	Purity			Germination			Number of samples below prescribed standard of germination	Prescribed percentage standard of germination
		Highest	Lowest	Average	Highest	Lowest	Average		
		%	%	%	%	%	%	%	
Oats . . .	1360	100	96·1	99·8	100	34	97	0·8	85
Wheat . .	685	99·9	90·5	98·8	100	58	97	4·1	90
Barley . .	194	100	94·0	99·2	100	70	97	2·6	90
Rye . . .	17	99·9	86·9	96·7	99	41	90	17·6	80

Oats.—The average purity and average germination of samples were identical with last year's averages. Only 11 samples or 0·8 per cent had germinations below the Government standard of 85 per cent.

The principal varieties submitted were those of Potato, Yielder and Victory, next in importance being Star, Early Miller and Marvellous.

Fifty samples of Black Oats out of a total of 70 (71·4 per cent) and 200 samples of White Oats out of 1290 (15·5 per cent) contained *Avena strigosa.* Three samples of Black Oats contained over 2 per cent, the highest being 3·5 per cent. No samples of White Oats contained this impurity to the extent of over 2 per cent.

Out of 1360 samples examined, only one sample had visible traces of Smut.

Wheat.—Samples of seed wheat have steadily increased in number since the establishment of the Wheat Commission. The average purity of samples was identical with that of the previous season while the average germination was 1 per cent higher. 28 of the samples (4·1 per cent) were below the Government standard of germination (90 per cent).

The principal varieties submitted for test were White Victor, Million, Standard Red and Red Marvel. Next in importance were Little Joss, Squarehead's Master and Wilhelmina.

The number of samples visibly infested with Ear Cockle was 21; 11 contained visible traces of Bunt while one contained a visible trace of Smut.

Barley.—The average purity and average germination of samples were 0·1 per cent and 2 per cent respectively higher than the averages of purity and germination of the previous season. The number of samples falling below the Government standard of germination (90 per cent) was 5, which is equal to 2·6 per cent, whereas the previous season 14 per cent of the samples were below the standard. The principal varieties received for test were those of Plumage Archer and Spratt Archer. Eight of the samples contained visible traces of Smut.

Rye.—The average purity was 2·3 per cent lower than that of the previous season but the average germination was 6 per cent higher. Three of the samples were below the Government standard of germination (80 per cent).

STATISTICAL RESULTS, 1935-36

ROOTS, VEGETABLES AND PULSE

VARIETY	Number of samples	AVERAGE PURITY	AVERAGE GERMINATION	NUMBER OF SAMPLES BELOW STANDARD OF		PRESCRIBED STANDARD OF	
				Purity	Germination	Purity	Germination
		%	%	%	%	%	%
Turnip	341	99·1	92	0·9	7·7	97	80
Swede	342	99·1	89	8·8	15·0	97	80
Rape	46	98·9	98	2·3	...	97	80
Cabbage and Savoy . . .	97	99·3	83	2·1	8·2	97	70
Kale and Borecole . . .	75	98·4	88	2·7	2·7	97	70
Brussels Sprouts . . .	20	98·9	88	5·0	5·0	97	70
Broccoli	19	98·7	83	10·5	5·3	97	60
Cauliflower	32	99·4	85	...	...	97	60
Carrot	110	94·6	74	8·2	3·6	90	50
Parsnip	24	96·2	74	75·0	8·3	90	45
Beet	82	98·2	78 clusters	11·0	1·2	97	50 clusters
Mangel	32	99·0	86 clusters	...	6·3	97	60 clusters
Peas —Field	20	98·0	97	15·0	...	97	80
Peas—Garden	84	99·6	93	1·2	1·2	97	70
Beans—Field	33	98·2	96	21·2	6·5	97	90
Beans—Garden	26	99·3	95	7·7	...	97	60
Vetches	41	98·3	98	4·9	..	97	90
Onion	79	99·7	77	...	11·4	97	60
Spinach	...	...	...	...	...	...	...
Leek	45	98·3	74	...	...	...	...
Lettuce	21	98·9	92	...	...	...	...
Radish	8	98·3	92	...	...	...	...
Mustard	4	99·6	92	...	...	...	...
Burnet	3	86·3	65 shoots	...	...	...	...
Sheeps Parsley	7	96·7	77	...	...	...	...
Parsley	6	96·9	75	...	...	...	...
Chicory	16	94·7	89	...	...	...	...
Ribgrass	19	91·0	90	...	...	...	...
Yarrow	11	94·2	75	...	...	...	. .
Brassica nigra	1	99 8	87	...	...	...	...
Linseed	4	96·9	93	...	...	...	...
Miscellaneous	6	...	...	...	...	...	...
Real Miscellaneous	3	. .	...	...	...	...	...

The average purity of the various kinds of vegetable and root seeds is similar to that of last season with the exception of Parsley and Parsnip, the former showing an increase of 8·4 per cent, the latter a decrease of 1·1 per cent.

A comparison of the average germination with that of last season gives the following results:—

	per cent
Mangel, Lettuce	+4
Turnip	+3
Swede, Broccoli, Beet, Radish	+2
Parsnip, Leek	−7
Mustard	−5
Cabbage, Savoy, Kale, Borecole, Sheep's Parsley	−3
Carrot, Garden Beans, Parsley	−2

Forage.—Samples consisted chiefly of Rape, Tares, Ribgrass, Chicory and Yarrow. The average purity recorded is practically the same as last year with the exception of Ribgrass and Chicory, which show an increase of 1·3 per cent and 1 per cent respectively. The average germination of Chicory and Tares shows an increase of 4 per cent and 1 per cent respectively while Burnet, Yarrow and Ribgrass show a decrease of 54 per cent (shoots), 8 per cent and 2 per cent respectively.

TREE SEEDS

European Larch.—Forty-four samples were received for analyses, being an increase of 19 on the number received last season. The highest purity was 97·9 per cent while the lowest was 49·7 per cent, the average being 72·5 per cent. This is 7·2 per cent lower than the average purity of last season. The highest germination recorded for this species was 60 per cent while the lowest was 4 per cent, the average being 19 per cent, a decrease of 14 per cent on last year's average germination.

Norway Spruce.—Twenty-nine samples were received, being an increase of 23 on last year's number. The average purity was 96·2 per cent and the average germination 72 per cent. The average purity and germination recorded for the previous year was 93·9 per cent and 88 per cent.

Scots Pine.—The average purity was 97·2 per cent and the average germination 76 per cent while the previous season's averages were 97·9 and 90 per cent.

FIELD TRIALS

Evergreen Perennial Rye-grass.—Thirty-seven samples described as Kent Evergreen Perennial Rye-grass which were received in 1934-35 for analyses were sown out to ascertain whether they were genuine Evergreen Perennials. It was found that 14 of the samples were undoubtedly genuine while 16 were fairly genuine. The remaining 7 were considered to be no better than ordinary commercial Perennial.

Cocksfoot.—Sixty-four samples described as Akaroa Cocksfoot grown in New Zealand were received in 1934-35 for analyses.

Portions of these were sown out to ascertain whether they were genuine Late Flowering Cocksfoot. It was found that 20 were genuine and 26 fairly genuine, while the remaining 18 were indistinguishable from ordinary Danish Cocksfoot. Six samples of English-grown Akaroa Cocksfoot were sown. None of these resembled genuine New Zealand Akaroa Cocksfoot, nor did 3 samples described as Danish-grown Akaroa Cocksfoot. Four samples described as English Cocksfoot were sown out for trial but these were found to be no better than Danish Cocksfoot.

Red Clover.—Fifty samples described as Montgomery Late-flowering Red Clover were sown out. Forty of these were considered to be absolutely genuine and 8 were fairly genuine, while one was undoubtedly a mixture of ordinary and Late-flowering Red. The remaining sample was ordinary Broad-leaved Red.

Wild White Clover.—A meeting of the Wild White Clover Committee took place on 25th July 1936, when the plots of certified Wild White Clover were inspected. These consisted of type samples received during the season 1932-33 and sown in May 1933 (14 Grade A and 12 Grade B), and type samples received during the season 1933-34 and sown in May 1934 (35 Grade A and 8 Grade B). It was noted that a few of the plots lacked vigour and were slightly earlier in flowering, especially some of the Hereford lots, but it was agreed that all the plots represented genuine Wild White Clover.

PART II—PLANT REGISTRATION STATION

Report for the period 1st August 1935 to 31st July 1936

REGISTRATION OF NEW VARIETIES OF THE POTATO

In 1935 the Potato Registration Committee recommended that the new variety Arran Peak raised by Mr D. Mackelvie, Lamlash, be registered, this variety having been under test for three years. The Committee also recommended that three varieties in their third year of test should be included for further test in the extended maturity and yield trials along with other five varieties which had already been under test for two years. Of the 38 varieties undergoing their first year of test, nine were recommended for a second year's test.

In 1936 there were 8 varieties in the third and fourth years of test and 9 in the second year of test, the latter comprising 7 varieties recommended in 1935 for further test, and 2 recommended in 1934 for further trial, but not submitted in 1935 owing to the raiser having insufficient stock. Two of the varieties recommended in 1935 for a second year of test were withheld from the 1936 trials for a similar reason. There were 24 varieties entered in the first year trials, this figure including one variety which was re-entered at the raiser's request; in addition one variety, which later proved to be identical with the standard variety Adirondack, was entered for an identity test alone.

LABORATORY WART DISEASE TESTS

The provision of determinations of susceptibility of new varieties to Wart Disease has been continued as a general service.

Reports on the degree of susceptibility of varieties are issued in terms of the following classification:—

(*a*) No trace of infection by the Wart Disease organism during test.
(*b*) Radial galls (incipient infections) present.
(*c*) Types of infection intermediate between (*b*) and (*d*) present.
(*d*) Definite warty tissue developed.

(Varieties contracting (*b*) and (*c*) types of infection are regarded for practical purposes as immune from Wart Disease.)

The maximum number of varieties accepted from any individual is 80 for single-tuber tests or 20 for four-tuber tests, with a limit of 100 tubers in all.

The tests are carried out according to the routine method described in the report for the year 1932-3.

The following is a statement of results of tests of seedling varieties submitted by breeders during season 1935-6:—

Number of single-tuber samples . . .	147
Number susceptible	56
Number of two-tuber samples	14
Number susceptible	12
Number of four-tuber samples . . .	32
Number susceptible	5

Inter-Departmental Tests.—Varieties to the number of 28, in ten-tuber samples, were tested in accordance with the standing instructions of the Inter-Departmental Committee on Wart Disease testing. One variety contracted Wart Disease consistently in this test as well as in a pot test in the open. The others reacted to infection but not to the extent of the (*d*) grade. Four of the varieties, re-submitted to test for confirmation of previous findings, reacted in grade (*c*); in five instances the disease developed to the point of forming Winter Sporangia.

Registration Tests.—Varieties submitted for the first time numbered 24. Four of these proved susceptible. The remainder reacted in grades (*b*) and (*c*).

WART DISEASE FIELD TRIALS

The field trial in 1936 consisted of a test whereby varieties were grown in pots out of doors under conditions which ensured heavy infection and sufficient moisture.

Inter-Departmental Tests.—There were included in these tests 19 varieties received from the English and Irish Wart Disease Stations, 3 of these being under special test, and 9 varieties distributed to these centres. One of these varieties proved to be susceptible, confirming the laboratory finding.

Preliminary Registration and Immunity Trials.—Twenty-three varieties were included in these tests including 5 which were duplicated in the inter-departmental tests. Four of these varieties proved susceptible confirming the laboratory result in 3 cases. One variety which proved susceptible in the laboratory showed no symptoms in the pots and one variety proved susceptible in the pots but not in the laboratory.

VIRUS DISEASES OF THE POTATO

The scheme for the synthesis of the various diseases as found in the field has been continued and the produce will again be demonstrated in field plots. The results obtained from the synthesis of disease appear to give a definite lead to a means of assessing the susceptibility or otherwise of a variety to the mosaic viruses. Since the work started in 1935, 24 standard varieties and 29 seedlings have been tested, most of the tests having been done in duplicate. In conjunction with this work a large number of the various grades of mosaic disease, drawn from all over Scotland, have been analysed for virus content. From this work a considerable amount of information is being obtained with regard to the incidence of the different viruses throughout the country, and also with regard to the actual virus constituents which are contained in the different diseases laid down as standards by the Inspectors' Potato Committee. Further information on the rate of increase from year to year of leaf-roll and severe mosaic in the different districts has been collected. These figures taken in conjunction with the results of the other work noted above promise to be of definite value so far as schemes for the production of healthy seed are concerned. Other points having direct connexion with the field work are being investigated.

Notes from Agricultural Colleges

Craibstone

Potatoes, 1936.—The season of 1936 was characterised by several distinct features which had a considerable effect on the yield of different varieties of potatoes.

The chief of these were (1) the wet cold weather in spring which delayed planting except in a few cases where the soil was naturally dry; (2) the subsequent continued cold dry weather, especially in June, which dried up the soil and prematurely ripened early planted early varieties, especially when sprouted; (3) the wet spell in July which caused excessive weakly growth; and lastly the incidence of blight in September which destroyed the shaws of most late varieties before many of the tubers had time to become fully developed.

The effect of these features are very clearly seen in the following results obtained with Golden Wonder, Majestic and Di Vernon, which were planted in a naturally dry soil at fortnightly intervals, beginning in the middle of March. Half of each variety at each planting was sprouted and the other half unsprouted. All the figures relate to yield per acre.

GOLDEN WONDER

Time of Planting	Sprouted								Unsprouted							
	Ware Over 2″		Seed 1¼″-2″		Small		Total		Ware Over 2″		Seed 1¼″-2″		Small		Total	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
March 16th	6	16	9	6		10	16	12	2	12	4	15		11	7	18
April 1st	4	9	8	10		10	13	9	3	3	6	8		13	10	4
April 16th	3	13	6	14		18	11	5	2	6	4	14		10	7	10
May 1st	3	11	6	1		16	10	8	1	19	5	15		13	8	7
May 16th	1	4	6	11		13	8	8		8	5	11	1	1	7	0
June 1st	...		6	1		16	6	17	...		4	14	1	3	5	17
June 16th	...		5	18		18	6	16	...		2	12	1	8	4	0
MAJESTIC																
March 16th	9	9	10	19		13	21	1	7	11	9	4		16	17	11
April 1st	9	17	11	1		19	21	17	6	17	9	17		19	17	13
April 16th	12	10	8	10		16	21	16	5	10	9	9	1	2	16	1
May 1st	10	11	8	16		8	19	15	7	3	6	14		13	14	10
May 16th	7	14	8	2		11	16	7	3	17	8	16	1	2	13	15
June 1st	6	12	6	12		8	13	12	1	5	6	12	1	4	9	1
June 16th	2	12	7	19	1	4	11	15		14	5	2	1	7	7	3

In the case of Golden Wonder, it will be seen that with the sprouted seed the earlier the planting the better the yield and there was a gradual reduction with each subsequent planting. With the unsprouted, however, those planted earliest were not so good as those planted a fortnight later. This result has been obtained on several previous occasions. Golden Wonder is naturally slow in sprouting, and especially at this season of the year when the temperature of the soil is comparatively low the unsprouted takes a much longer time to start growth, whereas the early start that the sprouted seed gets enables it to keep the lead. After the rain in July the earliest planted formed tubers instead of growing luxuriant shaws as did the later plantings, especially when unsprouted. On the other hand, when the shaws of all the plantings, both sprouted and unsprouted, were destroyed by blight in September, the latest planted ones were only in the process of forming tubers, hence their comparatively low yields.

With Majestic, there was little difference in the total yields obtained from the first three plantings of sprouted seed. This was probably due to the growing season being sufficiently long for all these to form tubers. There was, however, a gradual reduction from each later planting. In the case of the unsprouted there were again substantial reductions compared with the sprouted, the first two plantings being best and the late plantings much less.

It is interesting that, except in the case of the first two plantings of sprouted seed and the last one, there was not nearly so much difference in the height and luxuriance of the shaws as in former years. This was undoubtedly due to the fact that all benefited equally from the heavy rain in July.

It is often supposed that most " seed " is obtained from late planting, but it will be seen that with both these varieties there was generally most when they were planted early, and also when sprouted.

Part of the Di Vernon from the first three plantings was lifted on 3rd August, the other part being allowed to become fully ripe. At the time of the first lifting the difference between the height and vigour of the shaws was very marked. Those sprouted and planted on 16th March suffered considerably from the continued cold dry conditions; the plants were only 9 to 10 inches high and were beginning to ripen, many of the leaves having the characteristic curl of this variety at this stage when it ripens prematurely under dry conditions. The unsprouted were about 18 inches high, the leaves being well spread out and vigorous. Those sprouted and planted on 1st April were 14 to 15 inches high and had just reached the first stage of ripeness. The unsprouted planted then and all the later plantings were well over 2 ft. in height and looked very vigorous, although the growth was weakly. None of them showed the ripening curl on the leaves at any time.

The yields per acre obtained were as follows:—

DI VERNON

(a) Lifted 3rd August

Time of Planting	SPROUTED								UNSPROUTED							
	Ware Over 2″		Seed 1¼″-2″		Small		Total		Ware Over 2″		Seed 1¼″-2″		Small		Total	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
March 16th	5	5	8	18	1	19	16	2	1	6	9	3	1	11	12	0
April 1st	3	13	10	10	1	9	15	12		10	5	19	1	6	7	15
April 16th	3	13	8	3	1	16	13	12	...		4	4	2	7	6	11

(b) Lifted when fully ripe

Time of Planting	SPROUTED								UNSPROUTED							
	Ware Over 2″		Seed 1¼″-2″		Small		Total		Ware Over 2″		Seed 1¼″-2″		Small		Total	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
March 16th	7	2	8	13	2	2	17	17	9	4	8	2	1	11	18	17
April 1st	9	19	9	14	1	17	21	10	8	16	7	9	1	6	17	11
April 16th	8	10	10	12	1	11	20	13	8	13	8	8	1	11	18	12
May 1st	8	18	7	12	1	1	17	11	8	10	6	14	1	7	16	11
May 16th	7	19	7	16	1	14	17	9	3	3	5	15	1	9	10	7

As one would expect, with the early lifted, the early planted sprouted seed produced the heaviest crop while all the unsprouted ones were considerably less than the sprouted. As the first, however, was almost ripe it gave only a slight increase when allowed to become fully ripe. The unsprouted and all the later planted ones, on the other hand, gave substantial increases in yield, the April plantings, both sprouted and unsprouted, producing heavier crops than the May plantings.

Part of a lea field had been broken up in sections during the last year or two, and last year three adjoining sections were in turnips, potatoes and oats respectively, while another section was broken up last winter. The four sections were planted the same day with Golden Wonder, the seed being the same size in all cases. No dung was applied to any of the sections and the artificials were the same throughout. The shaws after lea looked most vigorous and those after potatoes least. That the appearance of the shaws does not give an indication of the crop is seen from the following table, which gives the yield per acre in each case:—

GOLDEN WONDER

Grown after—	Ware Over 2″		Seed 1¼″–2″		Small	Total	
	tons	cwt.	tons	cwt.	cwt.	tons	cwt.
Turnips ...	2	5	7	14	6	10	5
Potatoes ...	3	6	6	17	5	10	8
Oats ...	2	15	7	6	5	10	6
Lea	2	11	5	17	6	8	14

The most interesting feature of the trial is the comparatively low yield after lea; in the other cases the yields were almost equal. Possibly the reason for this result is that the nitrogen supplied by the turf was too late in becoming available, so that although the shaws were better developed than those grown after the other three crops they were cut down by blight in September before tuber formation was so far advanced. Had the growing season been longer, as it often is, the result might have been different.

A question often asked is: "Is it better to spread dung on the surface beforehand and plough it in, or to spread it in the drill before planting?" Three plots were laid down to test this point, 12 tons per acre of dung being applied in both cases where it was used. All the plots got the same dressing (6 cwt. per acre) of a complete artificial manure. Di Vernon was the variety planted. The yields per acre obtained were:—

DI VERNON

METHOD	Ware Over 2″		Seed 1¼″–2″		Small	Total	
	tons	cwt.	tons	cwt.	cwt.	tons	cwt.
Dung spread ...	5	4	7	17	17	13	18
Dung in drill ...	4	14	8	13	13	14	0
No dung	4	6	7	15	15	12	16

These results show that the dung increased the crop by fully a ton per acre, which at present prices more than pays for it the first year without taking its residual value into account. There was very little difference in the yields obtained by the two methods of applying it.

During the last year or two there has been an increase in the number of poultry kept in fields, and one method is to keep about 40 hens in what are called fold units which are shifted every day. This is undoubtedly the best method so far as the pasture is concerned. It is estimated that the amount of nitrogen, phosphate and potash in the droppings from this number of hens would be equivalent to 4-5 cwt. sulphate of ammonia, 2-3 cwt. superphosphate and ½ cwt. muriate of potash per acre.

In order to test the value of the droppings on the next crop, several plots were laid off on a comparatively poor field. After a few weeks the droppings showed a beneficial effect on the pasture, which became very green and luxuriant. Owing, no doubt, to its immature nature, it was some little time before it was eaten by the cattle. Ultimately, however, it was well and evenly eaten down.

The field was ploughed up and Golden Wonder potatoes were planted. Part of both the folded and the unfolded plots got the usual dressing (6 cwt. per acre) of artificial manures, another part being left unmanured.

The yields per acre obtained were as follows:—

GOLDEN WONDER

METHOD	Over 2"		1¼"-2"		Small		Total	
Folded—	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Manured ...	1	13	8	15	1	3	11	11
Not manured ...	1	13	6	13	1	1	9	7
Not Folded—								
Manured ...	2	16	8	1	1	1	11	18
Not manured ...	2	3	6	9	1	1	9	13

Both with and without artificials the unexpected result was that there was a slightly reduced yield where the poultry had been folded; the decrease was in the larger tubers, there being a small increase of seed-sized tubers. Possibly the reason for this result is that the pasture used up all the available ingredients, and as it had been well eaten by the cattle there was less left in the soil than in the case of the unfolded part. The artificials in both cases gave satisfactory increases of fully 2 tons per acre.

Seed potatoes are often planted with so wide a variation in size as 1¼-2¼ inches. In order to test whether it would be better to plant them of a more uniform size, plots were planted with " seed " of Golden Wonder of the following sizes—1½-1¾ ins., 2-2¼ ins. and 1¼-2¼ ins. at 9 ins., 12 ins. and 18 ins. apart in the drill respectively. All the seed was sprouted.

The plants from the large seed came up quickest and were most luxuriant in growth, and were much riper when the shaws were destroyed by blight in September. The plants from the small seed, although smaller, were also regular in size. On the other hand, the plants in the 1¼-2¼ in. plots were, as one would expect, very irregular in size.

When lifted, the following yields per acre were obtained:—

GOLDEN WONDER

Size and Distance Apart	Over 2″		1¼″-2″		Small	Total		Seed required		Crop less seed	
	tons	cwt.	tons	cwt.	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
1½″-1¾″											
9″	4	19	6	14	7	12	0	1	12	10	8
12″	5	18	5	11	5	11	14	1	4	10	10
18″	6	12	4	4	4	11	0		16	10	4
2″-2¼″											
9″	3	15	9	8	10	13	13	4	12	9	1
12″	4	16	7	14	7	12	17	3	10	9	7
18″	5	13	6	12	6	12	11	2	6	10	5
1¼″-2¼″											
9″	4	13	6	17	8	11	18	2	6	9	12
12″	4	13	6	7	6	11	6	1	15	9	11
18″	5	18	4	12	5	10	15	1	3	9	12

As is usually the case, the large seed planted close produced the heaviest total crop, but when the amount of seed planted is deducted it is actually the smallest. The largest net crop was produced by the 1½-1¾ in. seed planted at 12 inches.

What size and distance to plant, however, depends very largely on whether one is growing the crop mainly for ware or for seed. For seed production the large seed planted close gave the largest amount, while for ware the smallest seed planted wide was best.

The only true test, however, is the financial one. As prices vary so much in different seasons, it is difficult to make a fair calculation. If, however, we take ware at £5 and seed at £6 per ton we shall get some idea of the most economic size and distance apart. The calculation shows that the large seed planted wide and the 1½-1¾ in. size planted close gave the best returns, while the large seed planted close, although it produced the heaviest crop, and the wide range of size (1¼-2¼ in.) at all distances apart, gave the least returns. If the difference in price between ware and seed is larger it will be still more profitable to plant closer in the drill when growing for seed.

In recent years several trials have been made where potatoes affected with scab were steeped in mercuric compounds before planting. None of these showed a beneficial effect. Where there was no "scab" in the soil the tubers from the untreated seed were as clean as those from the treated; when planted in soil where scab was present the tubers from both treated and untreated seed were equally bad.

This year a dressing of 1 cwt. sulphur per acre was applied in the drill at planting time to soil where scab had been bad in previous years. The result was that, although a good deal of scab was still present on the tubers, they were not nearly so bad as where no sulphur had been applied.

Freshly-cut grass, which is said to have a beneficial effect, was also tried, but it did not show to advantage, the tubers grown where grass had been applied being as badly scabbed as where no grass had been spread in the drill.

Biological Notes for 1936

The following notes are contributed by Mr E. WYLLIE FENTON, M.A., D.Sc., Edinburgh and East of Scotland College of Agriculture.

Weather and Water Supply.—No two seasons are alike, and this adds to the variety of the British climate. Although the period of spring and early summer in 1936 was distinctly dry there was a decided break in July and part of August. What is much more important, however, is the course of the weather over a period of consecutive years, and the fact that previous years may still leave their mark on vegetation and crops. One feature very noticeable was the effect of previous dry summers and seasons on springs and wells in the hills. In 1936, although water did run for a time from many of these wells and springs, the wet part of the year did not greatly increase the flow of water. In late autumn many springs were almost dry. This was most unusual in several places, but it was the cumulative effect of several dry seasons. The combined effect of the failure of water to flow from all these wells and springs, especially in hill grazings, is serious. Often the best grazing parts are near these springs, and where the spring water gently overflows down the hillside. A series of dry summers reduces the area as well as the period of irrigation. This results in a serious reduction of the better grasses and a corresponding increase of the poorer grasses, or in other words there is a reduction of both quality and quantity, while the period of grazing is also reduced. It may require many years of well distributed and normal rainfall to redress the balance, and even then the result may not be the same. Another factor is the slowness of moisture to penetrate into the soil after the surface vegetation gets thoroughly dried up, especially if there is a mat of undecayed vegetation present.

Heather Beetle.—The year 1936 in certain western districts showed serious damage in heather moors. From such information as is yet available it would appear that in some places the ravages of this pest have been steadily increasing. Unless it is the peak period of an increase things do not look promising for the immediate future. It may be that the worst has been reached, but it will not be possible to reach any decision till far more information is available, and a very careful and accurate survey is made of all affected areas (Leslie & Shipley, 1912). The blackcock is about the only bird which eats the heather beetle. There is a distinct possibility, however, that much of the disease in heather may be due not so much to insect damage as to fungus disease. This possibility is at present under investigation.

Bracken.—The bracken problem is always with us. The chief difficulty is the cost of keeping this pest in check, while eradication is still more costly (Braid, 1935, 1936). While methods of destruction are being investigated, there is one aspect which seems to have been neglected. What is wanted is a use for bracken. So far it has not been successful in the making of paper. Half a century ago the use of bracken silage was advocated, but so far no further information seems to be available (Aitken, 1888). It can be used as a source of potash, but cannot compete with the present potash supplies. There still remains the question of manure. Bracken has in the past been used as litter (Russell, 1908), more successfully on heavy soils than on light, dry soils. Judging by some bracken placed in a barrel in Boghall Glen in the spring and summer of 1935, there may be possibilities of its use as a manure. The bracken was cut and tramped into the barrel. After finally making up the shortage the barrel was covered and stones placed on top. Unfortunately mischievous youths from town interfered with the barrel (a not unusual occurrence in Boghall Glen) and rain water entered and spoiled the attempt at silage. So the silage became manure! Young bracken at the "crozier" stage goes down into a very compact well-decayed mass. Older material is decreasingly successful, since the harder the stem the more difficult it is to rot. The bracken "silage" from the young "crozier" stage had an odour closely resembling that of pig manure, and as soon as it was turned out of the barrel, a considerable number of dung-flies suddenly appeared and immediately settled on the evil-smelling material. The "dung" from the older bracken stems and fronds had not quite the same dung-like smell, and the mature fronds and stems were only partly decayed and (in parts) distinctly mouldy. The possibility of treating bracken with "Adco" or a similar preparation is also worth consideration. Beyond scattering the material obtained on the nearby grass—mostly Nardus—no special trials were made. The "Nardus" so treated became darker green and was more readily grazed than the rest of the grass. It is hoped to continue this investigation. Meantime this possibility is worth small trials where there is plenty of bracken. A small pit or trench could easily be used instead of a barrel.

Weeds.—Some fields, both arable and grass, are far too weedy, and generally indicate a state of neglect. Bad weather and slow growth may aggravate this state of affairs, but in many parts it is not the result of one year but of several years' neglect that has brought about the present unsatisfactory condition of some farm land. The worst examples were seen in England, south to south-west of London. Many wheat fields told their own tale—wheat grown for the quota, no care taken of the land, and some wheat fields now in such a condition that it must be a loss instead of a gain in spite of the quota. In both cereals and grassland the Field Thistle (*Carduus arvensis*) is in some districts far too common. It is strange how long the belief lingers that this plant does not set seeds. Perhaps a more vigorous campaign with the Ministry of

Agriculture's excellent film on the subject might finally break down this old illusion. Another weed which is rapidly gaining ground is the Ragwort (*Senecio Jacobea*) erroneously called the Tansy in some localities and " Stinkin' Willie " in certain parts of the north-east. Docks (*Rumex*) are also far too plentiful even in hay crops. The Corn Production Acts (Repeal) Act, 1921, provides the legal power to enforce action when necessary for the destruction of Ragwort (*Senecio Jacobea*), Docks (*Rumex obtusifolius* and *Rumex conglomeratus*), Field Thistle (*Carduus arvensis*) and Spear Thistle (*Carduus lanceolatus*). Several places were visited where this Act might have been applied with great success. There seems to be either difficulty in applying the Act, or great reluctance to enforce it.

The Use of Cattle on Hill Grazings.—It is always unsound to indulge in one-sided grazing. In some parts of Scotland the hill grazings have been grazed by sheep alone for two centuries or more. Further, the numbers of sheep have been increased, and often more rapidly maturing types requiring more food have replaced the older, smaller, and slower maturing breeds. The result is reflected in the present vegetation (Fenton, 1936b). Many of the older writers severely criticised this method. Several show that by the use of cattle not only was the grazing greatly improved, but it carried more sheep with the extra cattle still grazing, and that the losses in sheep were much reduced.

The introduction of Galloway Cattle to Boghall Glen (Edinburgh and East of Scotland College of Agriculture) has afforded further proof of this statement (Wilson, 1936). Similar results have been obtained recently in Ettrick Valley.

The writer recently discussed this point with Professor R. G. Stapledon. He fully confirmed the advantages gained by the use of cattle on hill grazings. He also pointed out that even although it might be argued that the cattle did not pay, it did pay in view of the improvement of the grazing and in the health of the sheep. In other words the cost of cattle grazing is debited to "cultivation." It has also been noted in Wales that, since the introduction of cattle, diseases of sheep and infections (worm) have diminished. Even horses or ponies had a beneficial effect. This can be seen in many parts of Dartmoor (Devonshire), where sheep, cattle and ponies are all found grazing the grassy vegetation. One other point should be remembered. The spread and increase of bracken is also largely bound up with the disappearance of cattle from the rough and hill grazings (Fenton, 1936a, 1937).

Rabbits.—Every year there is a Rat Week. Does the rat do more damage than the rabbit? If sufficient reliable evidence could be collected, the probability is that it would be evident that the rabbit does quite as much if not more damage. Why is there not a National Rabbit Week? In the history of most species of animal there is generally a peak period when the number rises to a very high figure. If at present the rabbit is not nearing such a period, it is a dangerous situation for agriculture. This year in many parts of Britain the rabbit is present in phenomenal numbers. What is more important in many districts is that there does not seem to be any serious effort to keep this pest under control. The losses in some districts are already serious, and must amount to a very large sum financially. Not long ago it was customary in most districts to snare and shoot, and thus keep the rabbits under reasonable control. It is evident in certain areas to-day that the rabbit is very nearly out of control. It may be that Nature will soon " restore the balance," but that is not a certainty. It is not a thing which one can rely on, for many of the natural enemies of the rabbit have been, or are being, destroyed by man. The damage done by rabbits does not end with what they eat in crops and vegetables, not to mention trees destroyed, but they foul the land with their droppings (if plentiful) and render the ground dangerous for treading on by beast and man, and frequently undermine banks, causing small landslides and soil erosion. It is stated that rabbits are scarce, or their numbers are kept down, if the prices for skins and meat are good. There is much truth in the statement, but the price for skin and meat does not nearly repay the loss and damage done by the rabbits. Even if merely killed and buried or disposed of in some other way, surely it is still a saving of money to agriculture and a sound financial proposition? Suitable and persistent propaganda would do much to arrest the present apathy to the damage caused by this pest. Unless care is taken the rabbit may become as serious a problem as bracken.

The House Sparrow.—When one talks of vermin the House Sparrow is seldom mentioned. Has there ever been any serious attempt to estimate the yearly damage done by this bird? It affects not only the farmer but also the gardener. If not the most destructive bird, then it must be ranked as one of the most destructive birds we have. Its lack of size is compensated for by its numbers and its audacity. One more question, which may not be too easy to answer—What useful purpose does the House Sparrow serve to either the farmer or the gardener? The activities of this bird total up heavily on the debit side. In its distribution it is almost entirely confined to the haunts of man. It is never found far from houses or farm buildings. It eats and destroys vast quantities of grain and wantonly destroys many garden flowers, particularly in the spring when flowers are scarce. Yellow primroses and crocuses were its favourite, but now there is no colour ban. In some town gardens it is practically impossible to obtain Scilla flowers. In a very short time sparrows can completely undermine and destroy a thatched roof. Among other birds of its own size it is a regular bully. In the old days there used to be sparrow clubs. It would be a distinct gain if suitable and persistent means were adopted to diminish severely the number of sparrows, and after this has been done, to prevent any further increase. In towns and cities far too many people put out bread which is eaten chiefly by the sparrow. If this bread diet was withheld the sparrow population would probably diminish. Sparrows do at times eat green fly or aphides, but we have never yet learned of an authentic case of a crop attacked by aphides being saved by sparrows.

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Potato Notes

The following notes are contributed by Mr T. P. McIntosh, B.Sc., Ph.D.

A close study of the potato plant seldom fails to reveal matters of interest. Major observations are incorporated in scientific papers but minor observations are seldom discussed in print. It is thought, therefore, that a collection of notes, such as the following, appearing from time to time, may serve the useful purposes of interesting readers generally and of drawing the attention of scientists to problems with which the practical man is confronted.

Potato Variations.—The writer suggested in 1923 that it might be useful to try the effect of excising eyes from potato tubers and inducing growth to develop from the deeper tissues. This was done at the Department's Station at East Craigs, but with no results. Some years later, a Russian worker published a paper in which successful results were claimed for the same method. The tests were repeated in Scotland, but again without success. In 1936, the writer carried out further tests, and, on this occasion, very definite results were obtained; indeed, a technique has been found by means of which success with certain varieties may be attained on every occasion.

The varieties, Golden Wonder, Gladstone, King Edward and Arran Banner were selected for test. All visible eyes were excised from the tubers before planting. From the beginning of June until the end of July, each tuber was lifted from the soil once a week and all growth was examined. It was found frequently that small eyes had been missed and that sometimes the eye tissue had been incompletely removed; indeed, these two factors probably account for the previous failures. The normal underground sprout of any variety is constant in colour in any particular soil; hence, on lifting tubers from the ground, it is very easy to observe colour abnormalities. Thus, the normal sprout of the Gladstone potato is deep red, whereas white and pale pink sprouts are abnormal. The success of the method for the production of colour variations, therefore, depends on the removal of normally-coloured sprouts and the cutting deeper into the tissue until the abnormal sprouts appear.

By excising the eyes and applying the above-described technique, plants with the following tuber variations were obtained, viz., white tubers from Golden Wonder and Gladstone; and tubers showing only very slight traces of pale pink from King Edward and Gladstone. This was not all, however, as aberrations in the foliage also appeared. Thus, plants developed which showed abnormally divided leaves, fasciation and foliage contortion.

It would appear that the Russian claims are not ill-founded, although the constancy of the variations remains yet to be tested. If they be constant, it seems that the matter is one that should interest plant breeders, as it might be possible to eliminate colour from an undesirably coloured, but otherwise useful, seedling.

Are Slow-sprouting Varieties abnormally susceptible to Leaf-roll?—Observations on a large number of seedlings seem to indicate that the very slow-sprouting types do succumb readily to leaf-roll. An analysis of the statistics relating to this disease in commercial varieties in Scotland supports the idea: Golden Wonder, Arran Consul, President and Bishop—all slow-sprouting types—appear to contract leaf-roll very readily. A few quick-sprouting varieties, *e.g.*, British Queen, are also very susceptible, but none of the slow-sprouting Scottish commercial varieties is resistant to the disease. The matter may be one of coincidence; yet it should be noted that the aphis, which is mainly responsible for the spread of the disease, is very particular as to the type of leaf it feeds upon and the young shoots are the most sought. It may be that, because of their slower growth, the foliage of the slow-sprouting varieties is the most succulent and the most attractive at the critical time of invasion of potato stocks by aphides. The point is one which could be examined by field experiment and is a matter of importance to plant breeders.

How far can the Chemist help us?—The chemist has assisted us as regards the composition of tubers, the use of manures, sprays and disinfectants, the differentiating of varieties and in other ways.

Tests, which have been carried out for some years now, give grounds for the belief that he may possibly help in other and equally interesting directions. It would appear that virus-infected tubers are more strongly reducing than healthy tubers, a property which may be readily determined by the use of a suitable indicator. If this be confirmed—the present information has been obtained by rather rough and ready methods—an advance will have been made. It has, moreover, appeared to the writer for several years that the susceptibility of potato varieties to certain virus diseases has some relation to the oxidase activity of the tuber tissue. Where this is high, the susceptibility appears to be great; where it is low, the varieties appear to be resistant. Should the chemist be able to define such a relationship, the matter will be of great importance in connection with the problem of producing virus-resisting potato varieties. The usefulness of such a relationship, moreover, would not be confined to potatoes.

Ultra-Violet Rays and the Potato Crop.—In U.S.S.R. increased potato crops have been obtained by vernalizing the seed tubers. The vernalization process consists of exposing the tubers for a period to daylight by day and light from electric lamps by night. In January 1936 the writer had a small number of half-tubers irradiated with ultra-violet rays, the corresponding half-tubers being retained as controls. The results were rather surprising: nine of the treated half-tubers, when planted, gave considerably larger yields than the control untreated half-tubers; two gave yields which were roughly the same as those of the controls; and only one gave a yield which was distinctly less than its control. Can such results be fortuitous? Repetition of the test alone will decide. The present knowledge concerning the processes of growth is such that a stimulus by the irradiation cannot be ruled out as impossible.

A Correlation in the Potato.—From time to time, the writer has pointed out correlations in the potato. An example is the peculiar colour associations found when the tuber colour lies in the cork. Morphological correlations have seldom been noticed.

The style of the potato flower may be thick or thin and the ovary may join the style abruptly or more or less gradually, *i.e.*, it may be blunt or pointed. Observations show that, as regards existing Scottish varieties and a large number of seedlings, thin styles and pointed ovaries are most common in those varieties the tuber cork of which is coloured and that in this group of varieties only is the combination of thin style and pointed ovary found.

Diseases in Golden Wonder.—During the recent dry seasons, Golden Wonder has suffered severely from a disease which is known under various names, but which is most often referred to as "sprain." The disease is characterised by a browning of the vascular tissue, so that when the tuber is cut the vascular ring is conspicuously discoloured and throughout the tuber there is a brown network. The symptoms are generally most pronounced at the heel-end. The non-vascular tissue is not discoloured and is frequently whiter than normal

So much confusion has arisen through the loose use of the term "sprain" that it may be helpful at this point to deal very briefly with some of the types of diseases which cause brown spotting and streaking of the flesh of potatoes. These may be described as follows:—

(*a*) *Internal Rust Spot.*—The flesh of the affected tubers shows rusty, brown markings, varying in size from mere specks to large blotches 1 c.m. or more in diameter and irregularly distributed. In severe cases, cavities may occur in the necrotic tissue. The precise cause of the disease is not yet satisfactorily determined. The disease is commonly found in Scotland.

(*b*) *Sprain.*—The cut surface of affected tubers shows arcs, or curved splashes, of dead tissue, arranged more or less parallel to, or concentric with, one another. These arcs often appear to have as their focal point either a lenticel or a slight abrasion of the skin of the tuber. Here again there is no satisfactory explanation of the cause of the disease, which does not appear to be very common in Scotland.

(c) *Net-Necrosis.*—This name is used to describe the first-year tuber symptoms of leaf-roll in the American variety, Green Mountain. The tubers are characterised by the browning of the phloem strands and phloem parenchyma both outside and inside the vascular ring.

There are other diseases of a like nature, but the tuber symptoms of these are not so readily described as those mentioned above. Some are definitely known to be caused by viruses, *e.g.*, Aucuba Mosaic and the disease caused by Virus F. Mineral deficiency also appears to be responsible for the presence of necrotic areas in tuber tissue. A common malady of many varieties is that which causes a discoloration of the vascular ring of the tuber from the heel-end to a point seldom more than ¼ of the length of the tuber.

It would appear, therefore, that although the new disease may not be identical with the American "Net-Necrosis," this term, used in its wide sense, is the most suitable at the present stage for descriptive purposes. It is certainly curious also that a large percentage of affected tubers produce plants with symptoms strongly resembling those of leaf-roll. This association, however, does not appear to be invariable and, in addition, tubers from Golden Wonder plants affected with primary leaf-roll and secondary leaf-roll have been found free from net-necrosis. It is quite possible that two diseases are involved, viz., leaf-roll and another, and that the symptoms are most pronounced when both are present; on the other hand, the disease may be a simple one. From its prevalence during the recent dry years and its comparative scarcity in those districts in which virus diseases are rare, one is tempted to conclude that a virus is the cause; microscopic examination has hitherto failed to reveal the presence of any organism. Here, then, is a subject in which the scientist can be of great help.

The browning of the vascular ring at the heel-end alone is often confused with net-necrosis. It has, however, no effect on the seed value of the tubers and would seem to be more of a blemish than anything else. It is common in many varieties, particularly Golden Wonder, in dry years.

Report of the Reorganisation Commission for Milk for Great Britain

THE Report[1] of this Commission was published in November as one of the series of Orange Books on Agricultural Marketing.

The Commission was appointed jointly by the Minister of

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[1] *Milk: Report of the Reorganisation Commission for Great Britain.* Ministry of Agriculture and Fisheries, Economic Series No. 44. To be obtained from H.M. Stationery Office, 120 George Street, Edinburgh 2 (and other addresses), either directly or through any bookseller, price 1*s.* net, or 1*s.* 5*d.* post free.

Agriculture and Fisheries and the Secretary of State for Scotland on 11th February 1935. The Chairman was Mr A. E. Cutforth, and the other members were Professor A. W. Ashby, Sir Iain Colquhoun, Sir John Orr and Miss D. S. Tomkinson. The terms of reference were:—

(*a*) to consider the working of organised milk marketing in Great Britain under Milk Marketing Schemes and its incidence on production, distribution and consumption, and to make recommendations for further improvement;

(*b*) to consider and report on the extent to which, and the manner in which, organisation could be facilitated by closer co-operation between the Marketing Boards concerned, or by the amalgamation of some or all of the Schemes, including any schemes under consideration, or by other adjustments, and to prepare schemes for giving effect to any such adjustments;

(*c*) to consider and report on the extent to which, and the manner in which, the organisation of milk marketing in Great Britain could be facilitated by closer co-operation between Milk Marketing Boards in Great Britain and the appropriate authorities in Northern Ireland.

The principal recommendations made by the Commission are:—

(1) The establishment of a permanent Milk Commission to assist the Government by planning a policy of milk production adjusted to the nation's needs. While the general executive functions of the Marketing Boards would remain untouched, the Commission stresses the need for the transfer to an independent and impartial body of certain powers at present exercised by the Boards. The principal functions of the permanent Commission would be (*a*) to assist in formulating a policy of production and sale for the milk industry, in which a number of different interests will have to be carefully balanced, (*b*) to fix producers' prices and buying prices which will give effect to that policy, and (*c*) to administer any funds made available by the Government for the assistance of the industry.

(2) Although the Commission recognises that certain advantages might follow from the establishment of a single milk marketing scheme for the whole of Great Britain, it recommends that the English Milk Marketing Scheme with the existing regional division should be retained. It is of opinion, however, that there is no justification for a multiplicity of schemes, and that there should be one scheme for the whole of Scotland in place of the three existing and two projected schemes. It is suggested that Scotland should be divided into four regions, viz., (i) South-West (comprising the western and south-western counties covered by the existing Scottish Scheme), (ii) South-East (comprising the eastern and south-eastern counties covered by that scheme), (iii) the area covered by the

Aberdeen and District Scheme, with the addition of the Counties of Moray and Banff, and (iv) the area covered by the North of Scotland Scheme.

(3) The existing four Marketing Boards have found it necessary to seek agreement between themselves on several matters of major importance. With two Boards there will still be problems of co-ordination, and the Commission recommends the establishment of a Standing Co-ordination Committee consisting of representatives of the two Boards and of Northern Ireland.

(4) Producers' prices should be fixed in advance by the permanent Commission for the several regions at levels estimated to be sufficient to bring into the market the quantities of milk required from those regions.

(5) The Commission should also determine the wholesale prices of milk for the liquid market and for manufacture, after considering proposals by the Boards and the other appropriate organisations, but distributive margins and retail margins should not be fixed.

(6) The Government should relieve the liquid milk market of any burden in respect of surplus milk, the amount required at the outset being estimated at £5,000,000 per year.

(7) The consumption of liquid milk should be stimulated, and supplies of milk should be provided at specially low prices for those classes of consumers who need milk most.

The report is unanimous, but is followed by a short addendum signed by Sir John Orr in which he emphasises the importance of increasing the consumption of milk from the point of view of public health.

General Assembly of the International Institute of Agriculture

THE thirteenth General Assembly of the International Institute of Agriculture was held in Rome from 5th to 10th October 1936. The United Kingdom delegation comprised Mr H. Ramsbotham, M.P., O.B.E., M.C. (Head of the Delegation), Messrs R. R. Enfield and F. Grant, M.B.E., of the Ministry of Agriculture and Fisheries, Messrs Charles Weatherill, C.B.E., and J. M. Ramsay, O.B.E., of the Department of Agriculture for Scotland and Mr D. A. E. Harkness of the Ministry of Agriculture, Northern Ireland.

In the interval since the preceding Assembly Baron Acerbo had been appointed President of the Institute on the resignation of Prince Potenziani, and M. van Rijn Vice-President on the death of M. Louis-Dop, who had held the vice-presidency since the foundation of the Institute.

Dr H. C. Taylor (Head of the United States Delegation) was appointed President of the Assembly, and Mr Ramsbotham Honorary President. Fifty-three countries were represented, the total number of delegates being 115.

The President's Statement, the Report of the Secretary-General and the Report on Finance showed that the Institute's work had been carried on during the preceding two years with efficiency, and that the financial position had greatly improved, partly through the strict application of the budgetary and accounting principles laid down in 1932 and partly through increased receipts.

The United Kingdom delegation took an early opportunity of stressing the need for ensuring that the statistical and economic work of the Institute should reach the highest standard of quality, on the ground that that work constitutes the most important and indispensable part of the regular services provided by the Institute, and a resolution to that effect was adopted.

It was also resolved that further monographs dealing with the production of and trade in commodities (such as those just published on Cotton and Meat) should be prepared.

A lively discussion arose on a paper presented on behalf of the Permanent Committee by Mr F. L. McDougall, C.M.G., on the subject of "Nutrition and Agriculture." The Institute was represented on the Joint Committee on Nutrition set up by the League of Nations, which issued a series of reports in the course of last year, and it was resolved that this collaboration should be continued. There was, however, a certain divergence of opinion regarding the validity of the views expressed by experts on the relative values of different kinds of food, and regarding the modifications in agricultural policy and practice that might result from giving effect to these views.

A scheme for regulating the salaries and conditions of employment of members of the Institute's staff, prepared by the Permanent Committee in accordance with a decision of the previous Assembly, was submitted for consideration. This is a matter in which the delegations of the United Kingdom and other Empire countries have for some time taken a leading part. To most of the proposals made in the scheme no exception could be taken, but that relating to pensions was open to several objections, and the United Kingdom delegation was successful in moving that it should be reconsidered by a small committee of actuaries to be nominated by Governments with a view to its modification and to its being put in force as soon as possible. It is a matter for great satisfaction that the salaries, methods of recruitment, qualifications, grading and promotion of members of the staff have now been placed on a better footing, and that a regular scheme for pensions has been adopted.

Simultaneously with the meeting of the Assembly, a committee of statisticians met for the purpose of preparing for the second World Census of Agriculture, to be taken in 1940. The work of this committee did not come under the cognisance of the Assembly, but a discussion took place on the delay in publishing the results of the first Census, taken in 1930, and on the method of publication, viz., in separate brochures relating to the various countries concerned. It was strongly urged by the United Kingdom delegation and others that a more summary and less expensive form of publication should be adopted on the next occasion. Further attention will be given to this question by the Permanent Committee and by future Assemblies.

The Assembly's proceedings were carried through without serious controversy, and there was an evident desire to ensure that the Institute should make the best use of the resources at its disposal for the benefit of agriculturists throughout the world, in these days of difficulty.

Fourth International Conference of Agricultural Economists, St. Andrews, 1936

THE Fourth International Conference of Agricultural Economists which took place at the University of St. Andrews between 30th August and 6th September obtained considerable attention and from almost every point of view may be considered to have been most successful. Some 200 delegates from 23 different countries were gathered together. Quite a number of farmers attended the Conference also and found a great deal to interest them. On the first evening of the Conference addresses of welcome were given on behalf of the University, the Department of Agriculture and other bodies. Later the importance of the Conference was recognised by His Majesty's Government when a reception was held in the Younger Hall of the University and it was a very fitting honour that the Right Honourable Walter Elliot and Mrs Elliot were present to receive the guests. Later in the week Sir Basil Brooke, Minister of Agriculture for Northern Ireland, paid a short visit to the Conference.

Naturally many of the delegates from overseas were anxious to combine attendance at the Conference with a practical insight into some of the more important types of farming and farm organisation met with in this country. A party of some 40 under the guidance of Mr Joseph F. Duncan and of the Advisory Agricultural Economists of the Colleges (each in his respective area) travelled from Glasgow through Perth to Aberdeen, thence to Inverness, down the Caledonian Canal, through Glencoe and by Loch Lomond back to Glasgow; then to Ayr and Girvan, through Galloway to Dumfries, and finally through Hawick and Kelso to Edinburgh. After the Conference there was a further week's tour on similar lines, from Edinburgh down through the West of England and Wales ending in London. Those who were fortunate enough to go on these tours would appreciate the complexity of British farming and the innumerable variations in size and type of farm in relatively short distances. Visitors from overseas frequently ask what is a typical farm. Their tour will have left them wondering whether there is any such thing.

The Conference itself was presided over by Mr L. K. Elmhirst of Dartington Hall, Totnes, Devon, who has been President of the Conference since its inception in 1929. The proceedings were transacted in both German and English and the very up-to-date apparatus installed in the United College Hall together with the admirable bi-lingual qualifications of Dr Rolfes of the Landwirtschaftliche Hochschule, Berlin, as translator and interpreter, enabled continuity and interest to be maintained.

The main subjects under consideration at the Conference embraced a very wide field. At the Third Conference held at Bad Eilsen, Germany, in 1934 a large part of the programme had been devoted to outlining the measures of agricultural planning adopted by various countries. It was decided, therefore, that at the recent Conference consideration should be given to the main problems underlying these aspects of planning. Briefly these came under four headings:—

(*a*) The relation between agriculture and other industry and the community in general.
(*b*) The future of land tenure in relation to the development of agriculture.
(*c*) The future organisation of farming for production.
(*d*) The future of food consumption, in respect of purchasing power, health and dietetics etc.

Four days out of the seven were allotted to the study of these four problems. The remaining three days of the Conference were set aside for miscellaneous papers and informal discussions. Something like 30 full-length papers were given during the Conference so that only a short account of some of them can be given here.

Professor W. R. Scott, University of Glasgow, President of the Royal Economic Society, gave the opening paper on " The Relation of Agriculture to Industry and to the Community." He pointed out that there was a danger that agricultural economists, by their championing of the importance of agriculture, should place themselves in opposition or apparent opposition to other types of economic life. Opposition between industry and agriculture could only lead to one certain result—that both suffer from it. He considered the most outstanding problem which the agricultural economist must solve to be the reduction of costs. Industry had been concentrating on it for a century and a half; in agriculture it had been little more than begun. This offered the only opportunity of co-operation and mutual support between industry and agriculture, instead of conflict, in which the ultimate chances of agriculture being successful were very far from promising.

On the subject of "The Relation of Land Tenure to the Economic and Social Development of Agriculture" Professor Ashby, University College of Wales, and Dr Sering, Berlin, read papers. The former pointed out that if agricultural progress continued as in the past, agriculturists must constitute a dwindling minority of the total population. While the majority of the people were landless the only safe policy of re-distribution or re-allocation of land was through some form of ownership by the community. There were countries where the process of partition had gone far enough if not too far already. He very seriously queried the thesis that the occupation or ownership of land was necessary for security or liberty. As forms of economic and social organisation like co-operation, trade unionism and marketing organisation developed the importance of land tenure diminished. Dr Sering contrasted the system of land tenure in Britain and Germany; in his view the ownership of a small farm gave the German peasant more freedom than if he were a tenant. The farmers imparted great security and power of resistance to the whole body of the people. From these papers and the discussion that followed, it was apparent that comparisons between one country and another regarding land tenure do not lead very far. Professor Lattimer of Macdonald College, Quebec, pointed out that in Canada the owner-operation of large farms was a particularly vulnerable system in a period of the broad decline in land values. The liability was unlimited.

Papers on the problem of Agricultural Credit were read by Dr F. F. Hill, Deputy Governor, Farm Credit Administration, Washington, Mr E. H. Thomson, President of the Federal Land Bank, Massachusetts, and Mr E. Patka of Prague. Recent developments in the United States were very ably dealt with. One major task of the Farm Credit Administration was the stopping of wholesale foreclosures in the spring of 1933 by re-financing the debts of farmers. Here the problem of credit was closely linked with that of land tenure. At an informal session Mr Cairns, Secretary of the Wheat Advisory Committee, London, introduced a discussion on the world outlook for wheat. He foresaw, in the next decade, more rather than less governmental control of wheat.

On the third main subject before the Conference, "The Future Organisation of Farming," Mr A. Bridges, Deputy Director, Agricultural Economics Research Institute, Oxford, Professor H. Zorner, University of Berlin and Mr H. R. Tolley of the Agricultural Adjustment Administration (A.A.A.), Washington, contributed papers. Mr Bridges drew particular attention to the problem of organising British agriculture for most efficient production. Was agriculture, he asked, to be organised on the basis that makes for the highest efficiency in the use of land, labour and capital? Was this to be achieved by the further sub-division of farms or through medium or large-scale organisation? While there is some scope for improvement in the art of farming, did not the existing organisation stand in the way of advances that would result in appreciable reductions in the costs of production? Professor Zorner took the view that the development and encouragement of peasant farming—small family farms—was the most useful, taking all points of view into consideration. In the subsequent discussion two quite different points of view emerged. On the one hand it was held that until agriculture undergoes radical reorganisation such as other industries have undergone those engaged in farming, farmers and workers, will not be able to obtain the same standard of living as those in other walks of life, and they do not see why they should be held back. Other speakers maintained that agriculture is a form of economic activity quite unique. They would not measure the satisfactions of agriculturists, employees, peasants or farmers, by the same standards that they would apply to other members of the community. It is difficult not to feel that in this point of view the real welfare of those engaged in agriculture has become rather a secondary consideration.

Professor R. B. Forrester, University College of Wales, Professor E. P. Cathcart, University of Glasgow, and Dr M. K. Bennett of the Food Research Institute, Stamford University, California, dealt with the fourth main subject before the Conference, "The Problem of Consumption of Agricultural Produce." Professor Forrester surveyed the recent literature bearing upon human food consumption from the point of view of the economist. He concluded that while the "new nutrition," as he called it, has stimulated public interest in the relationship between low purchasing power and food consumption and made clearer the serious dietary deficiencies of large sections of the populations of different countries, it appeared difficult to consider it as a new approach to problems of poverty. These are questions of available real incomes and involve a consideration of the methods and policies by which the incomes, particularly of the relatively poor, may be increased. Professor Cathcart dealt with the nutritional aspect of consumption as revealed in dietary surveys among working class families in St. Andrews, Glasgow, Reading and Cardiff. His most striking point was that the investigators in all these studies had been struck by the ability shown by the untrained housewife in so apportioning her expenditure on available foodstuffs that the proportion of fat, protein and carbohydrate in the diet remained remarkably constant. He felt convinced, he said, that if once she concentrated on a strict academic conception of dietetics the chances were that she would not do so well. Dr Bennett surveyed the world position of wheat. Mr F. L. McDougall, Australia, urged in discussion that the most helpful method of solving the problems of consumption was by a revival of world trade.

It might perhaps have been advantageous had there been fewer full-length papers. It is obvious that with the best will in the world justice cannot be done to 30 papers in six days. More is to be gained from hearing and perhaps taking part in a full discussion on one paper in, say, a three-hour session, than from listening to three full papers, however admirable they may be, in the same time, with little time for discussion. Perhaps, however, the greatest value of such a Conference lies in the informal encounters and conversations that take place. Certainly from this point of view the Conference was a greater success than any of its predecessors. The University of St. Andrews was a very happy place in which to hold the Conference and the town and links of St. Andrews afforded an admirable setting. One visitor, however, determined to create a record by not even visiting the links, let alone playing on them.

Sixth World's Poultry Congress, Leipzig, 1936

THE inaugural meeting of the Congress took place on 24th July when addresses of welcome were given by the Governor of Saxony and the Mayor of Leipzig, and the Congress was declared open by the Reich's Minister of Agriculture, Herr Walther Darré. The speakers stressed the importance of such congresses in leading to a better international understanding, as well as in furthering the interests of the poultry keeper.

As is the usual practice, the Congress was divided into two sections: (1) paper-reading and (2) the national educational and live-stock exhibits. The famous Leipzig Fair grounds made an ideal setting for the latter, while the papers could be listened to in comfort in the National Library close by. One lecture room was fitted with the Siemens simultaneous translation apparatus which enabled one to hear the papers in any one of the five languages of the Congress. Although the reception was not perfect it did represent a definite improvement on the usual method of interpretation in that a very considerable saving of time was effected.

The papers were classified under six heads: (1) Instruction and Organisation, (2) Nutrition, (3) Breeding and Heredity, (4) Hygiene and Disease, (5) Economics, (6) Rabbit-breeding; and at a session devoted to General Reports a variety of problems from all sections was discussed. The papers numbered in all 144, in addition to which 16 General Reports were read.

In Section (3) Dr Greenwood of the Institute of Animal Genetics read a paper on "The Physiology of the Moult in the Fowl," which he illustrated with lantern slides. In the Rabbit section a paper entitled "Rabbit Keeping in Great Britain" was prepared by Dr Pickard of the same Institute. The other papers contributed by Britain were (1) "The Role of Minerals in Poultry Nutrition" by Mr E. T. Halnan, (2) "Chick Sexing" by Mr W. Kennedy, (3) "Laying Trials" by Major Macdougall, (4) "Marketing" by Mr Stanley Street-Porter, (5) "Egg Quality Studies" by Mr A. J. Macdonald, (6) "Auto Sex Linkage in Theory and Practice" by Mr Michael Pease, (7) "Observations on Fowl Paralysis" by Major Dalling and Miss Warrack, (8) "Recent Advances in Research in Poultry Diseases" by Mr C. A. McGaughey, (9) "Economics of Egg and Table Production in England" by Mr F. S. Dennis and Mr D. H. Dinsdale, (10) "Pregnancy in the Rabbit" by Dr Hammond, (11) "Breeding Experiments in Rex-furred Rabbits" by Mr W. King Wilson.

The national educational exhibits are always an interesting feature of these Congresses, giving, as they do, a picture of the position poultry-keeping occupies in the national economy of the countries concerned and indicating the steps that are taken to ensure its preservation, and indeed its extension, as a profitable branch of husbandry.

Britain was particularly well placed in having the first stand from the entrance on one side of the avenue with the United States opposite. The British stand displayed a wealth of information, pictorial and written, as well as in the form of models, to show the extent of the industry in England and the facilities available for instruction, research and further development. The stand was organised by a Committee appointed by the National Poultry Council and the National Farmers' Union of England, and it was made financially possible, in part by a grant from the Treasury but largely by the money raised within the industry itself for the purpose.

The German exhibit was comprehensive and striking. Demonstrations were staged to illustrate the activities of the many organisations, such as the Reich Breeders' Association, the Settlers' Union and the Marketing Association, which have been set up by the Government in the interest of the breeder of small live stock. One exhibit showed, by means of a special apparatus invented by Professor Gräper, a developing chicken, from the embryo stage right up till its emergence from the egg.

The live-stock exhibits like those dealing with education were staged on a national basis. There were in all about 11,000 birds and 1,000 rabbits on view, of which, as one would expect, the bulk was shown by Germany. Britain's contribution was very small, comprising only 63 fowls, 21 ducks, 21 bantams and 4 rabbits, of which total Scotland was responsible for one entry each of Silkies and White Runner Ducks. The method in force in Britain of accepting entries on the basis of tendering is far from satisfactory; it does not encourage numbers or ensure the best of quality. An opportunity was lost of showing the world what Britain can do in the way of breeding poultry.

Visits were paid to the Agricultural Departments of Leipzig and Halle Universities, the Agricultural College at Hohenheim and the Poultry and Small Live Stock Institutes of Cröllwitz, Erding and Grosshüttenhof, as well as to farms in different districts. It was interesting to note the variety of stock kept at most of the teaching centres, some or all of the following being usually seen in addition to poultry,—sheep, goats, rabbits, silver foxes, beaver, nutria and silkworms.

Agriculture and all its side-lines are considered of major importance to the country and by financial assistance, supervision and the organisation of marketing, every encouragement is given to those who would embrace it either as a whole or a part-time occupation.

It is the policy of the Government to encourage the keeping of poultry rather as a branch of mixed farming than as a separate and large-scale enterprise. Hence the variety of the instruction provided at the centres established for this purpose. A two years' course in poultry husbandry qualifies for a post of a practical nature. Men spend one year on a general farm while women students undertake, in addition, household work and gardening. In both cases the second year is spent on a recognised instructional farm. For posts of an educational nature practical experience for a period of three to five years is insisted on in addition to the approved academic training. A training of 1¾ years at an approved training farm together with three months at a Government experimental centre prepares for what is called the Assistant's Certificate. The holder of this certificate may, after five years' practice, and provided he or she is then 25 years old, take the examination for the Master's Certificate which qualifies for posts of a higher grade. Further grades are prepared for by extending the period of instructional training.

The poultry-houses on the farms visited were designed on simple but apparently effective lines. The land over which the birds ran was well looked after and the feeding was based on the fullest possible use being made of home products; a considerable amount of experimental work is directed towards this end.

It was interesting to learn in the course of a visit to a feeding-stuffs factory that all mashes sold must, in addition to their analysis, have their composition declared in detail.

The most popular breeds in Germany appear to be the White and Brown Leghorns and the Rhode Island Red, but White Wyandottes, Light Sussex and Plymouth Rocks are also kept as well as the native breeds, the Reich fowl and the Black Rhinelander.

An interesting afternoon was spent at a fur factory which handles over 3 million rabbit-skins annually, the skins eventually being sent to the market as seal, beaver, blue fox, skunk, or anything else desired, except rabbit.

The admirable organisation of the Congress and the tours, together with the hospitality of the Germans and their readiness to give information, added very materially to the instruction and enjoyment of those who were privileged to attend.

Reviews

The Scientific Methods of Plant Protection, with Special Reference to Chemical Control. Second edition. H. Martin, D.Sc. Pp. xii+379. London: E. Arnold & Co. 1936. 21s.

On the publication, some eight years ago, of the first edition of Dr Martin's book on Plant Protection it was immediately recognised as the authoritative work in English on this subject; that a new edition should be called for in such a relatively short time is at once evidence of the public interest in the subject and of the important developments which have taken place in the general methods of plant protection since the first edition was published.

The work, while written in the first place for chemists, will be found equally suitable by those workers in applied biology who are specially interested in the protection of plants and crops from disease.

Dr Martin opens with a general discussion of crop pests and the classification of control methods; this is followed by chapters dealing with plant resistance to infection, the influence of external factors on susceptibility, and general methods of biological control. These sections are of much interest to the chemist as well as the general reader, as they give a clear discussion of the problem from the biological point of view.

The question of plant resistance is fully discussed and the methods employed in the production of resistant varieties explained. The fact that a resistant variety was capable of producing resistant seed has been known for a long time; Biffen in 1905 established definite proof of this and showed that the degree of susceptibility of cereals towards yellow rust (*Puccinia glumarum*) is a property which follows the Mendelian laws of heredity. The problem of the nature of plant resistance, which involves, as Dr Martin points out, not only the means by which the plant repels the parasitic attack, but also the method by which the parasite makes its attack, is an exceedingly complex one and has attracted much attention in recent years. Dr Martin believes that the further study of plant resistance and the practical application of the knowledge so obtained is likely to yield the most promising results in the future.

The influence of external factors on the susceptibility and liability of the plant to attack are discussed in detail; amongst these may be mentioned nutritional factors, *e.g.* the influence of fertilisers. Plants growing vigorously are less liable to attack than those in a weakly condition; too liberal nitrogenous manuring, especially with the readily available nitrates, creates a predisposition towards disease; in the same way, a deficiency of phosphates or potash predisposes the plant to attack.

Amongst other factors may be mentioned the general soil conditions, *e.g.* soil type, soil moisture, soil temperature and various climatic factors; the effects of modification of the time of sowing are also dealt with.

What may be called the chemical section, *i.e.* that dealing with fungicides and insecticides, is exceedingly well done. The methods of spraying and dusting and the use of " spreaders " are explained as well as the use of protective colloids, dispersing agents and the properties of emulsions.

In the subsequent chapters the preparation and properties of the fungicides are detailed and the sulphur and copper groups of fungicides and the arsenic group of insecticides are thoroughly discussed. Various organic insecticides are next dealt with. Chapters on weed killers, fumigants, seed treatment and soil treatment follow and the work concludes with a discussion of the relation between the toxic action and chemical constitution of the various substances employed, a subject on which, Dr Martin from his own work is well qualified to speak.

It will be seen that Dr Martin has written a comprehensive treatise on the whole subject of plant protection which can be recommended with every confidence to agricultural biologists and agricultural chemists, as well as to the advisory staffs of agricultural colleges and to horticulturists generally. It is also an excellent text-book for degree students.

The new edition has been largely rewritten and the printing, as compared with the first edition, greatly improved; full lists of references are appended to each chapter.

Dr Martin writes in a clear and attractive style and he is to be congratulated on the publication of such a notable work.

Regional Types of British Agriculture. Edited by J. P. Maxton, M.A., B.Sc., B.Litt. Allen & Unwin, Ltd., London. 12s. 6d. net.

This book is something new in agricultural literature. It is a descriptive survey of the Agriculture of Great Britain. Fourteen

Advisory Agricultural Economists have each provided lively and interesting descriptions of the main agricultural features of their "provinces," with particular reference to the multifarious types of farming carried on and a fifteenth has contributed an introductory survey. Finally the whole has been ably welded together in book form. The work is by no means exhaustive, it could not possibly be so, but the claim that it fills a gap in our agricultural literature is well founded. In a sense, and so far as Scotland is concerned, it brings up to date that part of the old Statistical Accounts which dealt with agriculture, though naturally it lacks the intimacy of those old books.

Statistics are almost entirely absent, in fact it is a book with a very popular appeal. It deserves to be widely read.

While conveying the vitally interesting knowledge of what is going on in our countryside and how it is organised it should also assist towards a better appreciation of the tremendous complexity of our agriculture. A fuller understanding of that at the present time would be most valuable.

Dairy Produce Supplies in 1936—*including Poultry and Pig Products.* Imperial Economic Committee, 1936. 2s. 6d. net.

Fruit Supplies in 1935—*including Vegetables, Flowers and Bulbs.* Imperial Economic Committee, 1936. 2s. 6d. net.

The value of the Weekly Dairy Produce Notes and the Weekly Fruit Intelligence Notes prepared in the Intelligence Branch of the Imperial Economic Committee has long been appreciated. The supplements to these two publications summarise in a convenient and eminently readable form all the information given in the weekly publications whilst comparative figures for previous years are frequently provided.

A summary of world trade in butter, cheese and eggs is included in Dairy Produce Supplies in 1935 which also contains a detailed account of trade in butter in the more important foreign countries. Supplies, sources, seasonal variation, prices and imports of butter, cheese, eggs and bacon are treated in considerable detail whilst a condensed tabulation of wholesale prices for dairy products from 1929 to 1935 is of great value. Six comprehensive Appendices deal with the import duties on dairy products, the quantitative regulation of imports into the United Kingdom, trade agreements with foreign countries and bacon and milk marketing schemes whilst the legislation effecting certain important exporting countries is also summarised.

Statistical data respecting fruit, vegetables, flowers, and bulbs are much more meagre than those for dairy produce. Fruit Supplies in 1935, therefore, is restricted mainly to a summary, arranged under commodity headings, of the imports of these particular products. A description of the fruit season 1934-35 in many foreign countries is appended whilst the tables relating to imports of fruit into the Irish Free State, Germany, France, the United States and the Scandinavian countries should prove of value. The section dealing with fruit consumption in the United Kingdom is also of interest.

Grain Crops. Imperial Economic Committee, 1936. 2s. 6d. net.

The general form of this report is very similar to that of other statistical publications issued by the Committee and by its predecessor, the Empire Marketing Board. This present report is not an annual one; it deals with the period 1928-35 and is mainly a statistical analysis of the world production of and trade in wheat, barley, oats, maize and rice in those eight years. Of particular value to those interested in the grain crop trade will be the very concise summary of customs duties and trade restrictions in the most important importing countries.

A price of 2s. 6d. net seems rather high for such a small publication. The Committee themselves refer to it as a pamphlet.

World Consumption of Wool, 1928-35. Imperial Economic Committee, 1936. 4s. net.

This large volume is complimentary to that published in 1935 under the heading " Wool Production and Trade, 1928-34." While that volume dealt exclusively with the production and export trade in wool, this present one deals particularly with wool consumption and the trade in wool products, in 46 different countries, in the period 1928-35. It brings together in a compact form statistics of available wool supplies, consumption and trade. The subject is treated with that completeness and thoroughness which has come to be associated with the work of the Imperial Economic Committee.

International trade in wool products has been considerably reduced following on the rapid development of national wool textile industries in many countries. At the same time, however, the demand for raw wool has been maintained and the increasing wool production of the world is still going into consumption. These are two salient features brought out in this Report.

In future and annually it is intended to issue a wool consumption supplement to the Committee's " Wool Intelligence Notes " in which the more important statistics in this volume will be brought up to date. This will be issued free to subscribers to the " Notes."

Agricultural Progress, the Journal of the Agricultural Education Association. Vol. XIII, 1936. W. Heffer & Sons, Ltd., Cambridge. Price 5s. net.

The object of the above-named Association is to further the interests of Agricultural Education and Research by mutual assistance and advice. With this end in view its members hold paper-reading conferences twice yearly, when matters of import relating to their work are discussed. At the end of each year the various papers read are published in the Journal. The volume under consideration relates to the papers read or given in the year 1935.

For some considerable time the Association has been greatly concerned about the whole question of agricultural education. A committee under the chairmanship of Professor N. M. Comber was appointed to go into the matter and a report has now been issued, which occupies the first place in the volume under review. This report, which is in every sense an authoritative one, comes at an appropriate time. The whole farming industry is undergoing drastic changes. It is desirable, therefore, that the place and purpose of agricultural education should be clearly defined in any policy which may be undertaken. The committee's view is that agricultural education should become part of the normal educational system in each rural area, and that the day-school education should be followed up by continuation classes which would cater for young people of 14-16 years of age who have left school and gone on to the land. Provision should be made for the county organisers to conduct classes in agriculture for students over 16, but wherever possible these students should enter a farm institute, agricultural college or university. Continuation classes should be held during the day, possibly one day a week. Reference is made in the report to the anomalies that arise at present when local authorities make financial provision for agricultural education. This subject receives considerable prominence in another paper read by Mr J. L. Evans.

At these conferences the agriculture of the areas in which the summer conference is held is usually described. In the present volume the agriculture of the counties of Somerset and Northumberland is thus dealt with. Soil acidity is the subject of two of the papers. In one, the correlation between soil acidity and the growth of different plants is dealt with; in the other an account is given of a survey of a large area in East Suffolk with a view to bringing home to the owners and occupiers of the land the necessity for liming. Such papers show that the Agricultural Education Association is fully conversant through its 500 members with the educational and research needs of the industry. The Journal should certainly be in the hands of every agricultural teacher.

Journal of the Orkney Discussion Society. Vol. XI, 1936. To be obtained from the Secretary, Orkney Agricultural Discussion Society, Junction Road, Kirkwall, Orkney. Price 1s.; post free 1s. 3d.

As a class the Orkney farmers have justly earned for themselves the reputation of being amongst the most progressive of all British farmers. Ample evidence of this is forthcoming in the pages of the Journal, now in its eleventh year. The density of fowls per 100 acres arable in the year 1934 reached the abnormally high figure of 549—an increase of about 25 per cent in a single year. The export of cattle from these islands also showed a remarkable rise between the years 1934 and 1935. After standing at about the 9,000 level for several years, it suddenly went up to over 11,000. Such increases may be achieved at the expense of some other branch of the industry, but when we read that in the course of a decade the land under crops and grass in Orkney, so far from showing a shrinkage, has expanded by something like a thousand acres, we are assured that here we have something substantial, and we may be pardoned, therefore, for wondering wherein the secret of prosperity of the Orkney farmer lies.

The various papers included in the Journal show that in the technique of the industry the Orkney farmer has every desire to be up to date, particularly so far as science as applied to agriculture is concerned. First comes a well-informed paper on Common Diseases of Sheep in Orkney by George Johnston, M.R.C.V.S. Such various subjects as minerals and vitamins, threshing mills, marketing schemes and reclamation methods are all discussed very fully.

The quality of the various articles, most of which were given as papers by local farmers, is quite on a level with that of those published in previous volumes. Here is a rural community which is making real progress in spite of an ungenial climate, rather poor primeval soil and distance from markets. The determination of the Orkney farmer to make the best of things should be a stimulus to those who live in more favoured areas.

Bulletins of the Ministry of Agriculture and Fisheries.

The following Bulletins have recently been issued by the Ministry of Agriculture and Fisheries, and may be obtained at 120 George Street, Edinburgh, and the other sale offices of His Majesty's Stationery Office at the prices stated, which do not include postage.

Bulletin No. 92. *Chrysanthemums* (2s.).—Chrysanthemum-growing has now become a very important branch of horticulture in the United Kingdom. Although the total output of this crop has never been officially estimated, it is now reckoned that its wholesale value is not less than one million pounds. When it is recalled that less than thirty years ago the estimated gross value of all cut flowers was reckoned to be only £120,000, the growth of the industry is indeed remarkable. The present bulletin deals exhaustively with such preliminary matters as situation, soil, climate and housing. The production of new flowers by hybridization and sporting is fully dealt with, as well as the taking of cuttings, the cultivation during the growing period, disbudding, packing and marketing.

There is an excellent list of varieties, in which the merits of each are assessed. The bulletin is well got up and, as a mine of interesting and valuable information, should be in the hands of every grower in the trade.

Bulletin No. 101. *Methods of Hedge and Tree Stump Clearing* (9d.). It would seem at first sight that in view of the steady shrinkage of our arable acreage there could be little chance of any machinery specially designed for hauling up hedges or tree roots being utilised in agriculture. In fact, however, modern plant, whether operated by hand or power, can be utilised successfully and economically to clear away obstructions in the shape of unnecessary hedges and overgrown or old trees.

The adaption of power-operated machinery in the agricultural industry has made steady strides during the past few years. Greater progress would have been made had the fields been larger, and in many instances landlords and farmers have rid themselves of many of their old hedgerows in order to allow their tractors fuller scope. Economic considerations mainly determine whether or not such work can be done. Farm tractors with winch attachments, gyro-tillers, monkey winches and timber jacks can all be used. Complete descriptions of the methods employed are detailed in this bulletin, which also deals with the use of explosives and corrosive chemicals.

Bulletin No. 102. *The Cultivation and Harvesting of Sugar Beet on the Continent* (1s.).—This bulletin comes at an opportune time. The beet-growing industry in Great Britain has now reached the stage when a careful review of both its possibilities and its limitations should be made in the light of the experience gained by growers at home and on the Continent. In Great Britain the growing of sugar beet is a post-war development. In many instances the crops grown have not been so successful as they might have been had conditions of soil, cultivation, manuring, etc., been better understood. In particular, it is asserted that our yields are, in general, behind those of Continental farmers. It was considered advisable, therefore, to make a careful survey of the methods employed in the cultivation and harvesting of Sugar Beet on the Continent. Messrs Rayns and Wright, who carried out the survey, were well qualified for their task, and in this bulletin they have set down their findings in an admirable manner. It is pointed out that on the Continent sugar beet-growing is confined to districts where the soils are either naturally rich or in very good heart. The growers are usually within fifteen miles of a factory, and beet is generally the pivotal crop of the rotation. While methods of cultivation vary considerably with the class of soil and the rainfall, it is significant that in the following particulars greater care is given by the Continental growers than by ours. The seed bed is more carefully prepared; more attention is given to having as large a population of plants as possible; and manuring is on the whole on a more generous scale. On the other hand, the relative scarcity of skilled labour in Britain is reflected in the fact that many British growers are more skilled in utilising mechanical power. By such comparison, however, many interesting facts are brought to light, and both scientists and practical men can make good use of this interesting, useful, and well-informed bulletin.

Chemical Methods of Weed Destruction. H. C. Long and K. K. MacDowall. H. C. Long, The Birkins, Orchard Road, Hook, Surbiton. Price 6d., post free.

This pamphlet, which is reprinted from the *Journal* of the Royal Agricultural Society of England, Vol. 96, 1935, throws light on modern methods of weed-killing. Complete information on all points relating to weed destruction by chemicals is given in a clear and concise manner. By using suitable chemicals—*e.g.* sulphuric acid, calcium cyanamide, sodium chlorate, sulphate of copper, etc.—the weed population of fields can now to a very large extent be controlled. The technique of application must, however, be well understood, otherwise the task may not be done or injury be caused to the crop.

Wireless Talks on Agriculture

SCOTTISH

DATE	SUBJECT	SPEAKER
February 4th	Soil Research and the Farmer	W. G. Ogg, Ph. D.
„ 11th	Topical Talk	A. D Buchanan Smith
„ 17th	Junior Agricultural Clubs	A. R. Wannop, J. F. Duncan and another (discussion)
Tuesdays Wednesdays Thursdays Fridays	Market Prices	

NATIONAL

Mondays	For Farmers only	

NORTHERN

February 12th	Pig-keeping	W. B. Mercer and W. Dutton
„ 26th	Early Potatoes	A. M'Vicar

Tuberculosis (Attested Herds) Scheme

THE table on pages 88-89 gives particulars of the 39 herds of dairy cattle in Scotland registered as attested in terms of the Milk Act, 1934, Section 9, between 1st September and 30th November 1936.

The total number of herds attested up to 30th November is 182, comprising 14,793 animals. The following table gives the location of the herds in counties:—

Aberdeen . .	1	Brought forward	143
Angus . . .	2	Kirkcudbright .	11
Argyll . . .	1	Lanark . . .	12
Ayr . . .	117	Midlothian . .	4
Berwick . .	1	Peebles . . .	1
Bute . . .	1	Perth . . .	1
Dumfries . .	15	Renfrew . .	5
Dunbarton . .	4	West Lothian .	1
Kincardine . .	1	Wigtown . .	4
Carry forward	143		182

MILK ACT, 1934

Tuberculosis (Attested Herds) Scheme

Particulars of 39 herds added to the Register between 1st September and 30th November 1936, and one withdrawal

1. ADDITIONS:

County	Name of Owner of Herd	Address of Premises on which Herd is kept.		Date from which Certificate of Attestation was valid	Breed or Breeds of Cattle comprising the Herd	No. of Animals in Herd at Date of Attestation
			Parish.	*1936.*		
Angus	Corporation of Dundee (per Wm. Broatch)	Gourdie, Dundee	Dundee	23rd August	Ayrshire	233
	William Hunter	Auchrannie (& Lady Park) Alyth	Glenisla	2nd July	Mainly Ayrshire	55
Ayr	David Stevenson Clark	Silverwood & Polbaith, Kilmarnock	Kilmarnock and Loudoun	28th July	Ayrshire	176
	Do.	Little Maxwood, Galston	Galston	15th October	,,	19
	Mrs David Craig	High Ashyard, Hurlford	Galston	15th August	,,	68
	Bryce Cumisky Cunningham	Meadowhead, Mauchline	Sorn	1st July	,,	45
	Quintin Dunlop	Greenan, Longhill & Farden William, Maybole	Maybole and Kirkmichael	22nd July	Ayrshire and Galloway	163
	John Forsyth	East Collarie, Fenwick	Fenwick	11th August	Ayrshire	66
	Col. W. T. R. Houldsworth	Threave & Kirkbride House, Kirkmichael, Maybole	Kirkmichael	27th August	,,	82
	John Howie	Hillhouse, Kilmarnock	Kilmarnock	1st July	,,	95
	Rt. Hon. Jean, Countess of Inchcape (per H. J. Hewetson)	Low Kilphin, Ballantrae	Ballantrae	25th August	,,	41
	John Johnston	Braehead, Lugar	Auchinleck	17th August	,,	115
	Quintin Limond	Hareshaw. Fenwick	Fenwick	13th August	,,	92
	Robert Logan & Sons	Meikle Mosside, Kilmarnock	Kilmarnock and Fenwick	1st July	,,	96
	Thomas Howie Loudon	Gateside, Galston	Loudoun	30th July	,,	57
	Miss Margaret Watson Mair	West Collarie, Fenwick	Fenwick	1st July	,,	33

	David M'Kerrow	Croftfoot, Catrine	Sorn	9th August	,,	80
	Robert Mills	Boreland Mill, Cumnock	Old Cumnock	1st October	,,	4
	Gavin R. Morton	Midland, Fenwick	Fenwick	12th August	,,	93
	David Murdoch	Crofthead, Ochiltree	Ochiltree	29th August	,,	69
	Quentin Parker	Nether Broomlands, Lochwards & Chamberhouses, Irvine	Irvine	7th October	,,	78
	Robert Paterson	Megswell, Kilwinning	Kilwinning	20th October	,,	32
	Thomas Alexander Paterson	Marshalland, Beith	Beith	7th October	,,	40
	John Reid	Benbeoch, Fenwick	Fenwick	17th August	,,	56
	Mrs Mary Reid	Pencote, Dalry	Dalry	29th September	,,	76
	William John Thomson	Brae of Auchendrane & Whiteleys, Ayr	Maybole	27th July	,,	81
	Henry Wason	Wraes, Galston	Loudoun	26th August	,,	78
	John Milroy Williamson	No. 1 Holding, Southcraig, Kilmarnock	Kilmarnock	15th August	,,	34
BUTE	Her Grace the Duchess of Montrose (per George Laidler)	Home Farm, Brodick	Kilbride	29th August	Ayrshire and Red Poll	45
DUMFRIES	Wm. Brown	Drumcork & Hillend, Thornhill	Morton	27th October	Ayrshire	111
	William Halliday	Gilliesbierigg, Boreland	Hutton & Corrie	8th September	,,	87
	John Harvey	Nether Keir, Auldgirth	Keir	1st July	,,	61
	John Jamieson	Round Bush, Annan	Dornock	16th October	,,	87
DUNBARTON	Mrs Catherine Sutherland	Harestanes, Kirkintilloch	St. David	1st July	,,	34
KINCARDINE	Rt. Hon. Lord Carnegie, K.C.V.O.	Elsick Home Farm, Newtonhill	Fetteresso	31st July	,,	90
LANARK	Hugh Cooper Barr	Muirfoot & Broadhouselea, Lanark	Carstairs	1st October	,,	124
	James Mitchell	Muirhouse, Kirkmuirhill	Lesmahagow	1st July	,,	83
RENFREW	Robert Smith Andrew	Crossflat, Kilbarchan	Kilbarchan	20th August	,,	86
WIGTOWN	T. & W. A. H. M'Quaker	Gleniron, Glenluce	New Luce	1st July	,,	51

2. WITHDRAWAL:

The herd of Mr C. M. Bain, Corra, Castle Douglas, Kircudbright, has been transferred to Suffolk.

Agricultural Scholarships for the Sons and Daughters of Agricultural Workers and Others

THE total number of applications received in 1936 for scholarships was 121. Twenty-six scholarships were awarded, the number of awards in the various classes being as follows:—

Nine Class II Certificate course scholarships, tenable at agricultural colleges for courses of instruction in agriculture or horticulture, not exceeding twenty weeks in duration.

Six Class III Diploma course scholarships for courses of instruction for diplomas awarded by agricultural colleges in Scotland, and

Eleven Class IV Degree course scholarships for courses of instruction for degrees in agriculture or veterinary science of a Scottish University, or for the diploma of M.R.C.V.S. at the Edinburgh or Glasgow Veterinary Colleges.

LIST OF AWARDS—1936

For Degree Courses (4)—

William Aikenhead (Angus), at Edinburgh University and the Edinburgh and East of Scotland College of Agriculture.

Donald J. MacKinnon (Bute), at Edinburgh University and the Royal (Dick) Veterinary College.

Archibald Maclean (Inverness-shire), at Glasgow University and the West of Scotland Agricultural College.

William J. M. Spence (Zetland), at Aberdeen University and the North of Scotland College of Agriculture.

For M.R.C.V.S. Diploma Course (7)—

Donald I. MacInnes (Argyllshire), at the Glasgow Veterinary College.

John K. MacKay (Glasgow), at the Glasgow Veterinary College.

George A. MacKenzie (Lanarkshire), at the Glasgow Veterinary College.

Roderick Maclean (Inverness-shire), at the Royal (Dick) Veterinary College.

Malcolm M. Murchison (Inverness-shire), at the Glasgow Veterinary College.

Arthur M. Pomphrey (Argyllshire), at the Glasgow Veterinary College.

John G. D. Grant (Morayshire), at the Royal (Dick) Veterinary College.

For College Diploma Courses (6)—

William Baikie (Edinburgh), at the Edinburgh and East of Scotland College of Agriculture.

Miss M. Macdonald (Inverness-shire), at the West of Scotland Agricultural College.

Miss M. M. M'Lean (Inverness-shire), at the North of Scotland College of Agriculture.
William M'Nally (Wigtownshire), at the West of Scotland Agricultural College.
Miss M. K. Mutch (Aberdeenshire), at the North of Scotland College of Agriculture.
John Ross (Banffshire), at the North of Scotland College of Agriculture.

For Short Courses at Agricultural Colleges (9).

Studentship for Research in Animal Health

On the recommendation of the Agricultural Research Council the Department have awarded to Mr J. B. Brooksby, M.R.C.V.S., a Studentship for Research in Animal Health of an inclusive value of £300 per annum, tenable, as from 1st October 1936, for not more than three years. During this period Mr Brooksby will engage in research into animal physiology, and will work, during the first year, under the supervision of Professor C. Lovatt Evans at University College, London.

"Boots" for Sheep

A demonstration was given some months ago at the experimental centre of the Wye Agricultural College, Kent, of a rubber boot closely fitting a sheep's foot, and thus enabling dressings to be retained without the loss that usually occurs. At present, sheep suffering from foot-rot may have their feet dressed with ointment or other remedies and then be turned out without any covering on the wound. The result is that the ointment is soon rubbed off, and the treatment has to be renewed. The boot now introduced keeps the dressing in place, and experiment shows that normal cases of foot-rot can be cured in a week, with one or two dressings. The boot, which is proof against acid as well as water, is made in five sizes, and is shaped in such a fashion as to avoid chafing. It is a proprietary article, and may be obtained through trade channels.

Acreage under each Variety of Potatoes in 1936

A statement is printed below showing the acreage under each variety of potatoes in Scotland in 1936, as returned by growers of one acre or over. These returns cover 115,254 acres out of a total acreage of 133,057 acres, the difference, as in previous years, being chiefly accounted for by the total exclusion of certain districts in the Highlands and Western Islands, and by the exclusion of holdings on which less than one acre is grown. The total acreage shows an increase, as compared with 1935, of 1,461 acres, and the acreage included in the returns of varieties is greater by 1,256 acres.

The area under First Earlies, 17,709 acres, shows an increase of 1,300 acres, or 7·9 per cent, on the preceding year. Epicure, with a total of 9,576 acres, or 665 acres more than last year, accounts as usual for more than half the acreage. Eclipse comes next with 2,711 acres, being 273 acres, or 11·2 per cent, more than in 1935. Of the remaining thirteen varieties specified as First Earlies eight show a decrease in acreage.

The acreage under Second Earlies is 11,920 acres, or 888 acres less than last year. Great Scot, with a decrease of 727 acres, covers 7,627 acres, or 64·0 per cent of the total area under Second Earlies, as against 65·2 per cent last year. British Queen, with an area of 2,455 acres, 414 less than in 1935, accounts for a further 20·6 per cent of the total acreage. Other four varieties show increases, while the remaining four show decreases.

Maincrops, with a total acreage of 85,625, show an increase in acreage, over last year, of 844 acres. Kerr's Pink has again the largest acreage, 36,722 acres, and exceeds that of last year by 1,551 acres, or 4·4 per cent, and accounts for 42·9 per cent of the whole area. Majestic is second with an acreage of 14,995 acres, or 55 acres more than in the preceding year. King Edward VII and Golden Wonder, with 14,401 acres and 8,039 acres respectively, are the varieties showing the next largest acreages. Doon Star, with 2,776 acres, shows an increase of 1,061 acres, or 61·9 per cent. The area under Arran Banner, 2,822 acres, shows an increase of 135 acres, or 5·0 per cent, over that of last year. Of the twenty-two varieties specified, eight show increases, while the remainder show decreases.

Varieties immune from wart disease cover in all 77,761 acres, or 67·5 per cent. of the total area classified; non-immune varieties cover 36,795 acres or 31·9 per cent, while the varieties not specified in the statement account for only 698 acres.

STATEMENT showing the Acreage under each variety of Potatoes in Scotland in 1936.

A. *First Earlies*	VARIETY	ACRES
1.	*Arran Crest†	57
2.	*Arran Pilot†	770
3.	*Ballydoon	314
4.	*Dargill Early	35
5.	*Di Vernon	78
6.	*Herald†	26
7.	*Immune Ashleaf	31
8.	*Snowdrop (including Witch Hill)	38
9.	Beauty of Hebron (including Puritan)	63
10.	Duke of York (including Midlothian Early and Victory)	1,448
11.	Eclipse (including Sir John Llewelyn)	2,711
12.	Epicure	9,576
13.	May Queen	170
14.	Ninetyfold	467
15.	Sharpe's Express	1,810
16.	Other First Earlies not specified above	115
	Total First Earlies	17,709

B. *Second Earlies*	VARIETY	ACRES
17.	*Ally	187
18.	*Arran Comrade	148
19.	*Arran Luxury	130
20.	*Ben Lomond	103
21.	*Catriona	149
22.	*Edzell Blue	139
23.	*Great Scot	7,627
24.	*King George V	291
25.	British Queen (including Pioneer, Macpherson, Maid of Auchterarder, etc.)	2,455
26.	Royal Kidney (including Queen Mary)	574
27.	Other Second Earlies not specified above	117
	Total Second Earlies	11,920

C. *Maincrops*	VARIETY	ACRES
28.	*Sutton's Abundance (including Culdees Castle, Kerr's New White, Twentieth Century, Just in Time, etc.)	350
29.	*Arran Banner†	2,822
30.	*Arran Consul†	612
31.	*Arran Victory	245
32.	*Bishop	40
33.	*Champion	204
34.	*Doon Star	2,776
35.	*Dunbar Cavalier	152
36.	*Gladstone	250
37.	*Golden Wonder (including Peacemaker)	8,039
38.	*Irish Queen	100
39.	*Kerr's Pink	36,722
40.	*Langworthy (including Maincrop and What's Wanted)	171
41.	*Majestic	14,995
42.	*Rhoderick Dhu	63
43.	*Tinwald Perfection	97
44.	Arran Chief	1,244
45.	Field-Marshal	273
46.	King Edward VII	14,401
47.	Red King	814
48.	President (including Iron Duke and Scottish Farmer)	25
49.	Up-to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, etc.)	764
50.	Other Maincrops not specified above	466
	Total Maincrops	85,625
	Total area classified	115,254
	Acreage not included	17,803
	Total acreage grown	133,057

NOTES :—

1. The following districts are excluded:—In the County of Inverness: Skye, Harris, North and South Uist, and Barra. In the County of Ross and Cromarty: Western, South-Western and Lewis.

2. Returns showing a total of less than one acre under potatoes are not tabulated.

3. Varieties marked thus * are immune from Wart Disease.

4. Varieties marked † have been registered by the Department of Agriculture for Scotland as new varieties.

Labour on Scottish Farms

THE Agricultural Returns collected on 4th June 1936 give the following numbers of workers employed on that date on holdings exceeding one acre in extent. The occupiers of holdings, their wives and domestic servants are excluded, but other members of the occupiers' families are included.

	Regular Workers	Casual Workers
Males, 21 years old and over	59,707	6,370
Males under 21 years	19,909	2,787
Total	79,616	9,157
Women and girls	16,430	5,414
Total	96,046	14,571
Grand Total	110,617	

The grand total is 2,846 below that recorded in 1935; regular workers are fewer by 1,521, while casual workers are less numerous by 1,325. Of the regular workers, the number of men over 21 has decreased by 411 or 0·7 per cent, while those under 21 show an increase of 276. Women and girls regularly employed are fewer by 1,386, while all classes of casual workers of both sexes show decreases.

As compared with the numbers returned in the year 1921, when annual returns of labour began to be made, men over 21 are more numerous by 895, while the number of those under 21 has diminished by 3,378, and that of women and girls by 5,342, the total diminution in the number of regular workers being thus 7,825. The annual figures for casual labour hardly afford a fair comparison. The average number of male casual workers for the five years 1932-1936 is 9,540 and that of females 5,920, as compared with 10,600 and 9,700 respectively for the five years 1922-1926. There is clearly a reduction in the employment of casual workers, especially women.

Agricultural Returns, 1936

THE Abstract of the Agricultural Returns printed on page 109 shows that the total area under all crops and grass amounts to 4,592,377 acres. This shows a decrease of 6,170 acres as compared with 1935, the arable land being less by 6,916 acres, while the area under permanent grass shows a small increase of 746 acres. Rye-grass and other rotation grasses and clover have increased by 9,600 acres, the decrease in the " tillage " area being thus 16,516 acres.

The total area under the cereal crops is 999,618 acres, being 9,153 acres less than in 1935. Wheat shows a decrease of 7,002 acres, or 7·0 per cent, and barley a decrease of 4,280 acres, or 5·6 per cent, while oats show an increase of 1,872, or 0·2 per cent. The combined area under wheat, oats and barley is 994,755 acres, and is smaller by 9,410 acres than in 1935.

The area under potatoes is greater than in 1935 by 1,461 acres, or 1·1 per cent, but turnips and swedes show a decrease in acreage of 6,304 acres, and sugar beet 687 acres. Rape shows an increase in acreage of 108 acres, while cabbage has decreased in area by

769 acres and the area under vetches, tares, etc. for fodder is less by 781 acres. The area under flax is substantially greater with an acreage of 288 acres as against 20 acres last year.

Rye-grass and other rotation grasses and clover show an increase of 9,600 acres, the area for hay being greater by 256 acres and that for pasture by 9,344 acres. The area under permanent grass shows a small increase of 746 acres, that used for pasture being greater by 9,205 acres, while that grown for hay has diminished by 8,459 acres.

The returns of live stock in 1936 show a slight increase in the number of horses, while cattle, sheep and pigs show decreases. Horses used for agricultural purposes are fewer by 163, while unbroken horses over a year old have increased by 683 and foals by 393. The last-named class reached its lowest point in 1931 with 4,816 and now stands at 6,537, showing an increase of 1,721 or 35·7 per cent. "Other horses" are fewer by 751, and the increase in the total number of horses is 162. Cows and heifers have decreased by 2,182, and bulls by 594. Other cattle of two years and above again show an increase and are greater in number by 311, and those of one year and under two are more numerous by 1,806, but those under one year have decreased by 4,787 or 1·7 per cent. The total number of cattle has thus decreased by 5,446. Sheep are less numerous by 209,018 than in 1935, and show a total of 7,557,397. Breeding ewes are fewer by 30,327, but rams have increased from 96,117 in 1935 to 96,698 in 1936. Other sheep, one year old and above, show a reduction in numbers of 64,272, and those under one year a reduction of 115,000.

The total number of pigs, 236,384, is less than that of last year by 23,829 or 9·2 per cent. Sows are fewer by 3,076, or 9·6 per cent, than in 1935, boars by 211 or 6·9 per cent, and other pigs by 20,542 or 9·1 per cent.

The area of rough grazings, 10,410,692 acres, exceeds that of last year by 27,580 acres; included in this figure is the estimated area of land in deer forests used or capable of being used for grazing, which in 1936 amounts to 1,280,000 acres. The total figures for cattle and sheep include 2,022 cattle and 66,142 sheep grazing on the deer forests on 4th June. Of these, 1,298 cattle and 48,527 sheep were also included in returns made by agricultural occupiers; the necessary adjustments have been made so that no duplication has taken place in the statement of totals for Scotland.

The poultry figures are as follows:—

Fowls over six months old	3,780,178
Fowls under six months old	4,174,322
Ducks over six months old	147,521
Ducks under six months old	88,545
Geese over six months old	8,722
Geese under six months old	17,435
Turkeys over six months old	16,129
Turkeys under six months old	80,708
	8,313,560

The returns of labour employed on farms are summarised on page 94.

Agricultural Conditions in 1936

HARD frost, severe storms and in some districts heavy falls of snow occurred during January. The frost hindered ploughing, cultivation in many districts fell into arrears and very little field work of any kind was practicable. Severe weather prevailed throughout February and prevented the preparation of the land for spring sowing. Some progress was made with the carting of manure on to the fields, but farm work generally was very considerably retarded. During March the weather was rather varied, but was generally more favourable for land work. The weather was cold, dry and sunny during the greater part of April, with frequent ground frosts. Farm work made good progress, the arrears of spring cultivation being largely overtaken. Throughout the country the weather was exceptionally dry during most of May, and, while cultivation made good progress, the month was on the whole not a good one for farming, crops, grass and live stock being affected by the lack of moisture. Exceptionally dry weather conditions continued throughout June in almost all parts of the country. Pastures suffered from the lack of moisture, and in parts of Aberdeen grass sickness among horses was prevalent. Unsettled weather prevailed in most districts throughout the month of July. Heavy rains were general and interfered seriously with hay-making, but live stock pastures, potatoes and root crops benefited from the abundant moisture. Rains were frequent during the earlier part of August, and harvesting was retarded or only undertaken in difficult conditions. Fine weather set in towards the end of the month, but, on the whole, August was more of a growing than a ripening month. During the first half of September the weather was most unfavourable for harvest operations, rain, fog and the absence of drying winds seriously retarding the leading-in of grain crops; a marked improvement in the weather towards the end of the month, however, enabled farmers to complete harvesting in fairly good order. During October autumn cultivation made good progress, and potato-lifting was undertaken in ideal conditions. Wet and stormy weather during the last week of the month, however, held up farm work to some extent in many districts. During November conditions were generally wet and stormy, with a spell of frost and fog, and December was marked by a series of gales accompanied by a considerable rainfall.

The sowing of wheat in the autumn of 1935 was retarded by excessive rain. Where sowing had taken place early the braird generally suffered to some extent during January from severe frost, and by the end of March wheat had not made average growth. After the drought of May and June the crop benefited by the heavy rains of July, but the ultimate yield was below the average, and in several districts the crop was not up to the normal in quality.

Barley suffered in the early stages from continued dry weather, but rains during July assisted growth, although in several districts too heavy downfalls laid the crop. When harvested the crop, although of average bulk, was only a fair one as regards condition and quality.

Except in late districts, the sowing of oats had been mostly completed by the end of April. Germination was generally slow, and the crop did not make normal progress in May and June owing to lack of rain. In July growth was generally stimulated by rain, but in the north-east straw remained rather short. With a wet and protracted harvest crops were rather below average quality, and in many districts were stacked in poor condition.

Beans were rather slow to braird, but the plants later made strong and healthy growth, especially after the copious rains during July. By harvesting time crops were generally vigorous and healthy.

Dry weather and the good condition of the soil for working enabled rapid progress to be made with the planting of potatoes, which in many districts had been completed by the end of April. Subsequent dry, cold weather did not encourage growth, and, except where the tubers had been sprouted, the crop generally was rather backward. By the end of August, however, plants were in most districts looking well, and there was promise of good crops. Blight was apparent in various parts of the country, and disease appears to have attacked early and King Edward varieties more than others. Weather conditions for potato-lifting were generally favourable, and potatoes were pitted clean and dry.

By the end of May the sowing of turnips and swedes was well advanced in many districts, the condition of the soil being very satisfactory for the work. In the north and east early-sown crops throve well, but where sown later germination was slow and brairds were very irregular, resowing in some cases being necessary. Turnip fly was also troublesome in several counties, and some "Finger-and-toe" occurred. July rains saved the turnip crop in many districts, growth generally by the end of the month being vigorous and healthy. Further improvement was noted during September. In most districts crops were quite up to the average.

Mangolds had all been sown and plants were mostly appearing through the ground by the end of May. Plants subsequently made strong and healthy growth, although in a few districts more rain was needed. Generally, however, the weather conditions favoured growth in this crop which harvested well.

Sugar beet was sown in a good tilth, and in the early stages of growth withstood the dry conditions better than other crops. At the beginning of July singling was well in hand. Practically the whole of the sugar beet crop had been lifted in good condition by the end of November. The percentage of sugar content is generally reported to be good.

The weather conditions prevailing during the winter retarded the growth of rye-grass and clover "seeds," the crop suffered subsequently from cold and dry weather, and by the end of May was generally less promising than usual. Hay was adversely affected by wet weather conditions during July, and the work of hay-making was difficult and protracted, crops in practically every district being considerably damaged before being secured. Yields generally were very considerably below those of an average year.

Favourable weather during the first two weeks of October enabled autumn cultivation to proceed satisfactorily; manure was carted out steadily and early wheat sown in an excellent seed-bed. By the end of November the sowing of wheat was either well forward or had already been completed. Although held up to some extent by unsuitable conditions, the ploughing of stubble made fairly good progress.

Owing to severe cold weather and the absence of rain, pastures throughout the country continued to look bare until the end of June. Benefiting from wet conditions in subsequent months, grass made a good recovery, and in several districts pastures by the end of October were still plentiful. Dairy cows made fairly good progress during the earlier months of the year, but in June hand-feeding was necessary in many districts to maintain the yield of milk. By the end of March sheep stocks generally were in rather poor condition, hill ewes in particular having suffered from the inclement weather. In several districts heavy death-rates among both ewes and lambs were reported. It was a difficult lambing season and the fall of lambs was rather below that of a normal season. By the end of June lambs generally, owing to open weather conditions, were not so well grown as is usual at this time. Sheep made better progress in the autumn and were reported to be in healthy condition.

Annual Estimates of the Produce of Crops

The following Statement regarding the Produce of Crops in 1936 was issued on 17th December.

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Hay, Potatoes and Roots in SCOTLAND in the Year 1936, with COMPARISONS for 1935, and the AVERAGE YIELD PER ACRE of the Ten Years 1926-1935.

Crops		Estimated Total Produce		Acreage		Average Estimated Yield per Acre			Average of the Ten Years 1926-35
		1936	1935	**1936**	1935	**1936**		1935	
Wheat . . .	*Tons* *Quarters*	95,000 432,000	120,000 543,000	93,742	100,744	*Cwt* *Bushels*	20·2 36·8	23·8 43·1	21·8 38·8
Barley (including Bere)	*Tons* *Quarters*	66,000 343,000	76,000 390,000	72,233	76,513	*Cwt.* *Bushels*	18·3 38·0	19·8 40·8	18·4 37·7
Oats . . .	*Tons* *Quarters*	642,000 4,369,000	681,000 4,583,000	828,780	826,908	*Cwt.* *Bushels*	15·5 42·2	16·5 44·3	15·8 43·1
Hay from Rotation Grass .	*Tons*	578,000	687,000	396,679	396,423	*Cwt.*	29·1	34·6	33·2
Hay from Permanent Grass .	*Tons*	142,000	155,000	120,582	128,168	*Cwt.*	23·6	24·2	26·1
Hay from Timothy Meadows.	*Tons*	101,000	107,000	49,740	50,613	*Cwt.*	40·6	42·3	44·4

ANNUAL ESTIMATES OF THE PRODUCE OF CROPS—*continued*

Crops	Estimated Total Produce		Acreage		Average Estimated Yield per Acre		Average of the Ten Years 1926-35.
	1936	1935	**1936**	1935	**1936**	1935	
Potatoes . . *Tons*	990,000	886,000	133,057	131,596	*Tons* 7·4	6·7	6·8
Turnips and Swedes . . *Tons*	5,928,000	5,711,000	345,871	352,175	*Tons* 17·1	16·2	15·9
Mangolds . . *Tons*	71,100	51,000	3,202	2,409	*Tons* 22·2	21·1	19·9
Sugar Beet . . *Tons*	68,000	66,000	6,762	7,449	*Tons* 10·1	8·9	8·0*

* Average of 8 years only.

NOTE.—The outstanding features of the returns are the decreases in the production of the grain and hay crops and the increases in the production of the potato and root crops. Wheat shows a total produce of 95,000 tons, which is 25,000 tons less than in 1935. The area under the crop is less than in 1935 by 7,000 acres, while the average yield per acre, 20·2 cwt., is 3·3 cwt. lower than last year's yield, and is 1·6 cwt. lower than the average for the past ten years. Barley, with a total produce of 66,000 tons, shows a decrease of 10,000 tons. The area is less than in 1935 by 4,280 acres, while the yield per acre, 18·3 cwt., is less than that of last year by 1·5 cwt., and is slightly below the ten years' average. The total production of oats, 642,000 tons, shows a decrease of 39,000 tons. The area under the crop is greater by nearly 2,000 acres, but the yield per acre, 15·5 cwt., is 1·0 cwt. less than in 1935, and is 0·3 cwt. below the ten years' average.

The total produce of hay of all kinds, 821,000 tons, is 128,000 tons less than that of last year. Hay from rotation grass shows a production of 578,000 tons, which is 109,000 tons less than in 1935. The area is almost the same as that of last year, but the yield per acre, 29·1 cwt., has decreased by 5·5 cwt. Permanent grass, other than timothy, produced 142,000 tons, which is 13,000 tons less than in 1935. The area is less by almost 7,600 acres, while the yield per acre is also less than in 1935 by 0·6 cwt. Timothy meadows, with an average yield per acre of 40·6 cwt., which is 1·7 cwt. below that of last year, produced 101,000 tons, or 6,000 tons less than in 1935.

The total production of potatoes, 990,000 tons, is greater than in 1935 by 104,000 tons, owing to an increase of almost 1,500 acres in the area planted and an increase of 0·7 ton per acre in the yield; the yield this year is 7·4 tons per acre. The total produce of turnips and swedes, 5,928,000 tons, shows an increase of 217,000 tons. The area under the crop has decreased by 6,300 acres, but the yield has increased by 0·9 ton to 17·1 tons per acre. Mangolds, with an area increased by almost 800 acres, and a yield greater than that of last year by 1·1 ton, give a total produce of 71,100 tons, which exceeds last year's by no less than 21,100 tons.

The area under sugar beet is less than in 1935 by almost 700 acres, but, with an increase in the yield per acre of 1·2 ton, the production is greater by 2,000 tons. The yield this year is 10·1 tons per acre, which exceeds by 2·1 tons the average of the last eight years.

The yields per acre of wheat, barley, oats, hay from rotation grass, hay from permanent grass and hay from timothy meadows are lower than those recorded in 1935, while those of potatoes, turnips and swedes, mangolds and sugar beet show increases.

SCIENCE AND PRACTICE

The following extracts and summaries are mainly supplied by members of the staffs of Scottish agricultural colleges and scientific institutions. Full references to the original publications are generally given; if further information is desired regarding these, application may be made to the Secretary, Department of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh 2.

CROPS AND SEEDS

The Problem of Potato Breeding. *S. M. Bukasov. Amer. Potato Jour., 13,* No. 9 (September 1936).—The principal problem and final aim in studying the potato is to improve its yield and quality. The biology, physiology and biochemistry, disease resistance, breeding and genetics of the potato are being studied, and it is those branches of science that have engaged the interest of the research workers in Russia in recent years. Formerly most of the work was done with European and North American varieties. In recent years, however, much more attention has been given to South American varieties and species.

In order to obtain a wide range of material for breeding and for resistance to virus diseases, to drought and to frost, the Russian Institute of Plant Industry sent an Expedition to South America and Mexico in 1925, and this exploratory work was continued until 1932. The commercial varieties in the principal potato producing countries of the World are closely related to the Chilian potatoes forming the so-called species *Solanum tuberosum.* All other native varieties belong to a geographically isolated group grown only in the high mountainous regions of South America. Some species are characterised by immunity from various diseases. Immunity from *Phytophthora* (ordinary blight) has been found in some of the Mexican wild potatoes. Physiologically the species differ in vegetative period and the resting period of the tubers, frost-hardiness, the temperatures required for sprouting of the tubers and of flowering. In some species when cultivated in long-day areas the yield is considerably reduced and may even completely fail. Some of the wild potatoes, such as *S. commersonii, S. Vavilovii,* etc., have an extremely long period of rest. Species with long rest periods are interesting from the point of view of storing the potato under conditions of the South. From the economic standpoint it would be interesting to find species the tubers of which sprout at a lower temperature than those of the Russian varieties. This would permit of extra early planting of potatoes.

The new potato species are of great interest to the plant breeder; they open up new horizons and present new problems.

Of much interest and importance in connection with the new material is the problem of frost-hardiness of the potato haulm. The losses from late spring frosts, necessitating late planting of the tubers, and very early autumn frosts checking the most vigorous growth of the tubers, are great and universal. Wild potatoes such as *S. acaule* ascend to almost 16,000 feet near the line of perpetual snow. They stand temperatures as low as 18° F. Of much importance also is drought resistance.

Since the introduction of the potato into cultivation much attention has been given to the problem of immunity of the plant to many destructive diseases. In the struggle against wart disease, the breeding of wart-resistant potatoes has been practised in such countries as England, Germany and Switzerland. Greater difficulties have been met with in combating ordinary blight. The control of wart was possible within the limits of *S. tuberorsum,* but the latter species and its Chilian relatives have proved powerless against *Phytophthora.* Only the introduction of new blood, evidently of *andigenum,* gave rise to new varieties with increased resistance. The late maturity of this type, however, acted as a brake on the work of breeding for resistance, and up to the present time it has not been possible to produce an early variety resistant to blight. Many of the wild potatoes are entirely immune from blight, *e.g., S. demissum, S. verrucosum, S. polvadenium.*

The creation of varieties by means of inter-species hybridisation opens up a new line of potato breeding. *S. demissum* has given better results than certain other "wild" races. An especially interesting fact in the *demissum* hybrids is that in these not only the haulm but also the tubers are resistant. According to Rokhlina the tubers of *demissum* and *Antipoviczii* are not absolutely resistant to *Phytophthora,* but differ in the degree and character of the development of the organism. This same worker has established that resistant species differ from susceptible varieties in the Solanin content of their sprouts and vines, but not of the young tubers which usually contain no solanin. Some wild potatoes such as *S. leptostigma, S. araccpapa,* perhaps some *demissum, acaule* and *Bukasovii* are resistant to wart.

As regards the practical application of theories, formerly potato breeding was purely empiric, ignoring any theory both as regards initial material and the methods of mastering it. The new initial material ensures to plant breeding immunity to *Phytophthora*, frost-hardiness of the haulm, a wider range of vegetative period and resting period of the tubers. At the present time the principal method of breeding used is hybridisation with subsequent selection. It is suggested that much attention should be devoted to interspecific hybridisation with *S. andigenum*. An important role in crossing with this species is played by the choice of the partners. To obtain high cropping progenies in the F_1 generation of *tuberosum*×*andigenum* is evidently more difficult than in back-crosses of the F_1, and especially the selection of F_2×*tuberosum*. In F_2 and subsequent generations, in view of the omission of heterosis, the percentage of new varieties produced will possibly be lower. In hybridising with cultivated species having a different number of chromosomes back-crossing is indispensable.

The species chiefly used in breeding for frost-hardiness are *S. curtilobum* and *S. demissum*. As regards productivity promising results have been obtained from hybrids of *andigenum*.

At the present time there are sufficient data on potato growing from seeds to show the possibilities, not only as a breeding method, but in some cases as a method of growing potatoes in extreme northern or in mountainous regions of difficult accessibility or in regions infested with virus diseases. For germination potato seeds require a certain temperature and degree of humidity, and only careful growing of the young nursery plants will ensure further successful growth.

Undersogelser over Kaalroeforraadnelsen i 1934, foraarsaget af Bakterieangreb. (Investigations on a rot of swedes in 1934 caused by bacterial attack.) *By Aage Lund.* Tidsskrift for Planteavl, 41 Binds, 2 Haefte, 1936. Extract from Writer's Summary.—In 1934 the swedes in Denmark were strongly attacked by *Brevicoryne brassicæ* and *Contarinia nasturlii.* This attack was followed by a severe bacterial disease in the roots of the swedes. The bacterial attack begins at the neck of the root and spreads downwards causing a grey-brownish rot. Generally the diseased tissues are limited from the sound ones by a characteristic dark zone. The rot caused great damage not only in the fields, but was also rapidly spread in the pits. By means of isolations from the diseased tissues a green-fluorescent bacterium was found constantly present, sometimes accompanied by some other colonies. By innoculation of swedes in the field and of excised pieces of roots with pure cultures of the green-fluorescent bacterium, it was proved that this organism is able to cause the disease, the typical symptoms of the rot being produced. From the infected swedes the same bacterium was easily reisolated. On the contrary young plants of swedes (3 weeks old) in flowerpots were not attacked.

By means of the cultural characters of the organism (see the table, page 11), it did not seem possible to refer it to any other plantparasitic species than the imperfectly known "*Bacillus brassicævorus*" *Delacroix.* But due to the imperfect description of this species our bacterium cannot be identified with it with certainty. Our organism (=*B. Brassicævorus?*) is considered normally to live saprophytic in the soil. Through the wounds made by the insects mentioned it is able to penetrate into the swedes and then as a facultative parasite it attacks the interior tissues.

The variety Bangholm is very susceptible to the disease, whereas Wilhelmsburger seems to be considerably more resistant. A careful sorting of the swedes before storing in pits is thought effective in order to diminish the losses.

ANIMAL BREEDING

Beef and Dual Purpose Cattle Breeding. *W. H. Black.* 1936. *U.S. Department of Agriculture Year Book.* 863-886.—To locate the better strains of beef cattle the co-operation of the State Experiment Stations was obtained, together with a list of the best blood in each State. The survey shows that it is far from an easy matter to locate superior breeding stock. The writer believes that, until there is an adequate method for measuring beef characteristics, an effective survey of the improved beef cattle germplasm is not possible, and that the showyard cannot be taken as an index.

In analysing beef qualities genetically in addition to fertility and disease resistance, the important characters to be considered are weight for age, proportion of body parts, quality of carcase, and efficiency of feed utilization.

Previous research work in the United States is briefly described, including that of Gowen at Maine and Cole at Wisconsin with Aberdeen Angus and dairy breeds, the experiment at Alaska to develop a hardier strain of dairy cattle by crossing between Holstein Friesians and Galloways, the work of Gregory of California on size factors, as well as the workers at the U.S. Department of Agriculture. Record of performance tests, with special regard to economy of consumption, are considered. An experiment by the U.S. Department of Agriculture on Shorthorns shows that the range in feed consumed per one hundred pounds of gain varied from 304 to 473, a difference of over 60 per cent. The range in age at which a live weight of 900 pounds was reached was from 373 to 566 days, a difference of more than 50 per cent. Carcase grades showed a range of between 75 and 85 pounds. The data included calves by several sires, with wide variations even amongst calves by the same sire. The progeny of three bulls were tested. Those by the first were best in weight for age, economy of gain, and dressing percentage, but poorest in carcase grade. Those by the second were poorest in weight for age, economy of gain, and dressing percentage, but best in carcase. Those by the third bull were second in weight for age, economy of gain, and carcase grade, but equal to those by the first bull as regards dressing percentage. The problem of testing the dam is also described.

There follows an article on the problems which beset the breeder of dual purpose cattle, and a statement concerning the herd of dual purpose Shorthorns at Beltsville.

There is an appendix showing colour genes in cattle.

Improving Horses and Mules. *J. O. Williams and Wm. Jackson.* 1936. *U.S. Department of Agriculture Year Book.* 929-946.—Few of the States have experimental projects that involve a distinct genetic approach to horse breeding. The work of Laughlin with the racing capacity of the thoro'bred horse is referred to, and work in other parts of the world is reviewed.

The value of the Dynamometer as a measure for the pulling power of draught horses is stressed, but it is to be regretted that the country which invented the Dynamometer has not used it genetically.

There is a section on great sires of the American thoro'bred and standard breed. The standards for the mule are also stated, and on page 185 are reported some recorded cases of fertile mules.

Producing Better Dairy Cattle. *H. S. Willard and W. L. Quayle.* 1936. *Wyoming Agric. Exp. Stn. Bull. No. 215.*—This Bulletin reports the construction and development of the Holstein Friesian dairy herds associated with the Station, and gives particulars of the various bulls used in the different herds. The results emphasize the need of vigilance in the selection of sires, and the necessity for culling low producing cows.

Superior Breeding Stock in Poultry. *M. A. Juhl.* 1936. *U.S. Department of Agriculture Year Book.*—A list is given of dominant and recessive characters in chickens. There is a history of the development of poultry in the United States, and an account of laying tests, together with a statement of the progress achieved by record of performance accomplishments.

The low relationship between daughter and dam production is stressed, reference being particularly made to the work of Gooddale at Mount Hope.

The importance of progeny testing is emphasized as well as the characters requisite for determining egg production, and methods by which this may be achieved.

Swine—Some Current Breeding Problems. *H. C. M'Phee and O. G. Hankins.* 1936. *U.S. Department of Agriculture Year Book.* 887-905.—This article starts with an interesting table showing the different experiments being conducted on pigs at the different Experimental Stations in the United States. There are no fewer than seven Stations studying the effects of inbreeding, nine on linebreeding problems, and eight on crossbreeding and outbreeding. Only two, however, are measuring efficiency in pigs, but there are seven dealing with type. Most of these Stations are also studying the inheritance of incidental data, such as inverted nipples, kinky tails, hernia, resistance to disease, short toes, etc. A list is given of characters, the inheritance of which is now known.

Discussing inbreeding, the writers state that pigs are remarkable for their heterozygosity, and emphasize how desirable it is to establish inbred strains so that undesirable factors may be eliminated and suitable material produced for crossbreeding. The evidence shows that certain individual pigs do possess an hereditary basis for sufficient vigour to permit strains developed from them to persist under the system of inbreeding for five or more generations.

A note is added concerning experiments with new types of swine from Denmark.

Soft Pork. 1936. *Armour's Monthly Letter to Animal Husbandmen. 15*: No. 1. —There are two principal causes of soft pork, an American term which includes bacon. The first is due to the natural characteristics of the hog. There is no question but that there are some inherited differences with reference to firmness of flesh between different breeds of pigs, and probably between different strains within a breed. A study by Purdue University has shown that in general the British breeds of pigs have a tendency to make a firmer fat at lighter weights. The American breeds first lay on a soft fat, which becomes firmer, but not before the pigs have reached over 225 lb. live weight. Thus, the rate of maturity is a question of some importance in fattening pigs. It is only fair to note that there are certain strains in some of the American breeds which definitely show an ability to put on hard fat at lighter weights.

The principal portion of this paper, however, deals with the effect of feed. It is maintained that when pigs are full fed mature maize (corn) they do not, as a result, produce soft pork, which is caused by feeds other than maize.

The principal criminal in the United States is Soybeans. On no account should Soybeans be grazed or fed as beans to pigs. Soybean Meal, from which the oil has been extracted, does not soften the pork, and may be used safely.

The Production of High-grade Pigs. *V. C. Fishwick.* 1936. *J. Min. Agric.*, *43*: No. 3: 235-240.—Sixty-eight crossbred pigs were reared, all sired by the same Large White boar. Thirty-eight (Type I) were out of Essex Saddleback sows, and thirty (Type II) were out of Large Black sows. In addition, two groups were formed cutting across the types. Group I received standard mixture, receiving a quantity of food that would clear up readily. The maximum daily ration fed to pigs in Group II was restricted to 5½ lb. per head per day, and they did not receive that quantity till they reached 175 lb. live weight, at which period Group I were receiving 6¾ lb. The effect of limiting the ration was to produce a reduction in the thickness of the shoulder fat. The reduction was of considerable magnitude in Type I (out of Essex sows), but was insignificant in the case of Type II (out of Large Black sows). It was also noticed that there was a clearly marked difference in the thickness of the shoulder fat of the pigs of each type, Type II having greater thickness. Since all the pigs had the same sire the difference must have been entirely due to the dams.

Grading results showed that Type I improved in quality on the restricted ration, while Type II were approximately equally good irrespective of the ration.

Meal consumption varied from 481 lb. per 100 lb. carcase increase with Type I on Group I ration, while on Group II ration the figure was 486 lb. Type II on Group I ration gave 502 lb., and on Group II ration 510 lb.; the method of nutrition having thus a small, if any, effect on economy of food consumption, but Type I appeared to have been more economical than Type II. This may be explained in the carcase measurements since these were fatter pigs, and it takes more food to produce a pound of fat than a pound of lean meat.

Some Grading Results at an Eastern Counties Bacon Factory. *A. W. Punter.* 1936. *J. Min. Agric.*, *43*: No. 5: 440-445.—A chart has been prepared by Messrs Harris (Ipswich), Ltd., Bacon Factory, showing grading results from different herds classified according to breeding. One herd produced 90 per cent Grade A, and the remainder Grade B.

At the other end of the scale there were no Grade A, 3 per cent Grade B, 73 per cent Grade D, and 8 per cent Grade E. The figures also suggest the importance of strain within the breed. There was, of course, large differences of feeding between the different herds.

ANIMAL NUTRITION

Green Sprouted Forage for Feeding Purposes. *G. H. Wooldridge and W. C. Miller.* *Vet. Rec.*, 1936, *48*, 427-428. (Roy. Vet. Coll., London).—Reference is made to the Spangenberg process of forcing seeds till the plants are 10-15 inches high in about 14 days, and then feeding the plants as forage to stock. At the Veterinary College maize was the most suitable plant; if oats or barley are grown, " seeds " and " malting " varieties respectively must be used. The quantities fed were 7-10 lb. for horses, 15 lb. for heifers and 5 lb. for sheep per day. Its possible general uses are for young growing stock and heavily fed dairy cows in winter, for all stock in time of drought and for putting bloom on breeding or show stock.

Effect of Nutrition on Sexual Function. *J. S. Popoff, A. A. Salzman and N. A. Margoit.* *Ztschr. Züchtung B.*, 1936, *35*, 267-278. (Zootech. Inst., Moscow).—Three experiments are described. In the first the control ration (2 stallions) was 7 kg. hay, 6 kg. oats and 1 kg. bran with 30 g. each of salt and chalk. In the experimental rations part of the oats was replaced by an equivalent amount of maize (3 stallions), wheat (3), millet (2) or barley (2). All of the experimental rations gave good results as judged by quantity of ejaculate, activity, concentration, total production and viability of spermatozoa, that with millet giving increases under each heading.

In the second experiment the control ration was 7 kg. hay (half grass, half lucerne), 4·5 kg. oats, 1·25 kg. wheat bran and 1 kg. sunflower seed cake with salt and chalk. In the experimental rations the sunflower seed cake was replaced by equivalent amounts of soya bean meal, wheat bran, peas or wheat bran and grass. Wheat bran and peas gave definitely the best results, wheat bran best of all.

The control ration in the third experiment was 4 kg. grass hay and 3 kg. lucerne hay, 6 kg. oats, 1 kg. wheat bran with salt and chalk. In the experimental rations, the bran was replaced by 0·5 kg. dried brewer's yeast, or dried ground testis, or egg lecithin. Yeast gave less good results than the control ration and testis good results in one case.

The rations had a starch value of 5·85-5·95 kg. and a digestible protein content of 0·95-1·2 kg. The horses weighed 450-500 kg., and did not lose weight during the season.

The Quantities of Grass that Dairy Cows will Graze. *T. E. Woodward. J. Dairy Sci.*, 1936, *19*, 347-357. (Bur. Dairy Indust., U.S. Dept. Agric., Washington).—In this investigation groups of 2 cows were grazed on a certain area of grass for a given time, from 2 to 4 days. The cows were then removed and the ungrazed grass clipped as low as or lower than that on which the cows had grazed. At the same time an area of similar pasturage which had not been grazed was clipped and the difference between the quantities of clipped grass from the two areas was considered equivalent to the quantity of grass the cows obtained by grazing.

The results indicate that the limit of a cow's capacity is about 30 to 35 lb. dry matter in grass per day, depending on size. One cow grazed in a day about 6 per cent of the immature grass standing on 1 acre of ground. This means that a pasture would have to yield 2500 lb. or more of grass to the acre, with a dry matter content of 20 per cent, to permit a cow to graze her fill.

It is suggested that during the grazing season cows should have access to either hay or silage at least once a day to make up for any shortage of grass. This would ensure that the intake of nutrients would not be subject to great variations.

Experiment in the substitution of Ammonium Bicarbonate for Foreign Oilcake Protein in Feeding Milk Cows on Beet Silage. *P. Ehrenberg and v. Prittwitz. Landwirtsch. Versuchs-Stat.*, 1936, *125*, 101-118. (Agric. Chem. Inst., Univ. Breslau).—The results are given of a practical feeding test with two groups of 7 cows each. The allowance of ammonium bicarbonate was 100 g. per head daily. Total dry matter and starch equivalent were approximately the same for each group. The group receiving the ammonium bicarbonate gave about 15 per cent less milk than the oilcake group. This is partly accounted for by unsatisfactory consumption of the food. The percentage of fat in the milk was higher in the ammonia group, but otherwise there was little difference in the average composition of the milk. In neither case was there any appreciable effect on live weight.

The Nutritive Value of Proteins for Milk Production. Part 4. *S. Morris, N. C. Wright and A. B. Fowler. J. Dairy Res.*, 1936, *7*, 97-121. (Hannah Dairy Res. Inst., Kirkhill, Ayr).—In continuation of earlier work and using a similar technique the authors have investigated the nutritive value for milk production of the proteins of various forms of grass and silage, when they were balanced up, if necessary, with oats and maize.

In the first comparison it is shown that the proteins of spring grass are markedly superior to those of autumn grass as indicated not only by milk yield, but also by the urinary N and S and creatine excretions, and by calculation of biological value according to a formula given. Artificial drying of the grass did not appear to affect the nutritive value of the grass as indicated by the N and S metabolism of the cows. In the case of autumn grass there was no significant difference between the biological values of the proteins of the fresh and dried materials. With spring grass the proteins of the dried material showed a lower value for milk production than those of the fresh, but when these figures were calculated to a common basis of 75 for the biological value of low temperature dried blood meal these differences disappeared. The three types of silage were made from young summer grass, and their proteins showed no difference in nutritive value and had biological values equivalent to those of fresh spring grass.

Further evidence is produced confirming the earlier statements that the proteins of blood meal prepared by a high temperature process have a lower biological value than those of blood meal prepared by a low temperature process. The supplementary values of two poor quality proteins, one deficient in lysine and the other in tryptophone, have been demonstrated for decorticated earthnut cake (low in lysine) and ossein (a bone protein low in tryptophane).

The biological values arrived at in this and earlier work, on the basis of an arbitrary value of 75 for low temperature dried blood meal, are: fresh and dried spring grass, grass silage (made from summer grass), low temperature dried blood meal, 75-80 per cent: fresh and dried autumn grass, bean meal, pea meal, 60-65 per cent: high temperature dried blood meal, meat meal, 55-60 per cent: decorticated earthnut cake with or without flaked maize, 50-55 per cent: linseed cake, linseed oil meal, 45-50 per cent. These figures apply to the complete rations as fed (*vide* paragraph I), and account must be taken of the relatively high maintenance intake and the possible supplementary relationship between the proteins of the maintenance ration and of the production ration.

The effect of Variations in Feeding on Dairy Cows yielding Milk of Poor Quality. *A. W. Stewart and J. F. Tocher. J. Dairy Res.*, 1936, *7*, 1-13. (Rowett Res. Inst., Aberdeen).—In 4 cows giving milk low in solids not fat the percentage of solids not fat and the milk yield were increased by changing from winter rations to pasture. The values were slightly increased during the second lactation by feeding well balanced rations, but the percentage of solids not fat did not rise above 8·5. A high protein ration having albuminoid ratio 1 : 2·76 did not affect milk yield or casein, but decreased solids not fat and lactose and increased total N, albumin N and globulin N, whilst a high carbohydrate ration having albuminoid ratio 1 : 9·90 slightly decreased solids not fat, but did not affect milk yield, fat or ash. It is concluded that, although milk deficient in solids not fat can be improved in quality and quantity by adequate feeding, the predominating factor in its causation is hereditary.

The Nutritive Value of Artificially Dried Grass and its effect on the Quality of Milk. *S. J. Watson and W. S. Ferguson. J. Agric. Sci.*, 1936, *26*, 189-209. (Imp. Chem. Indust., Ltd., Agric. Res. Stat., Jealott's Hill, Bracknell, Berks.).—Two groups of 10 cows each of four different breeds were used in an experiment of 20 weeks' duration and in which the reversal method was employed. There were four periods of 5 weeks, each cow alternating between two treatments. In two of the periods an ordinary winter ration of roots, hay and concentrates was fed while in the other two periods dried grass replaced part of the concentrates, an average of 8 lb. being fed per head daily. The amounts of starch and protein equivalent were not affected, but the carotene intake was greater in the dried grass ration.

The inclusion of dried grass did not affect the quantity of milk or the quality in so far as the contents of fat and solids not fat were concerned. The periods were too short to show the full effect of the dried grass on the butter yellow-colour figures. There was, however, an obvious response to the increased carotene content of the ration, especially with the Guernsey breed.

The condition of the cows appeared to be better on the dried grass ration which showed a significant advantage over the ordinary winter ration as regards weight increases.

The Fishy Flavour of Milk caused by Feeding Beet By-products. *W. L. Davies. Agric. Progress*, 1936, *13*, 112-115. (Nat. Inst. Res. Dairying, Univ. Reading).—Trimethylamine oxide is the compound responsible for the fishy flavour taint in the milk of dairy cows fed on beet by-products. These by-products contain tertiary nitrogenous bases, one of which, betaine, is regarded as the precursor of trimethylamine oxide. It is the association of this oxide with the unsaturated acids of milk fat which causes the fishy flavour.

Feeding experiments with the nitrogenous compounds found in beet by-products were carried out to find the rate of output of tertiary nitrogenous base in the urine and their concentration in the blood and in the milk in the udder.

Precautions to be observed in feeding betaine-containing foods so as to avoid taint are suggested, and future work on this problem is outlined.

Effect of A.I.V. Silage on Butter Quality. *A. E. Sandelin. Milchwirtsch. Zentralbl.*, 1936, *65*, 147-149.—Observations extending over 7 years have shown that the feeding of cows with A.I.V. silage affects neither the commercial nor the keeping quality of butter.

The effect of Size and Type of Ewe on Efficiency of Production. *W. E. Hunt. Univ. Maryland Agric. Exp. Stat. Bull.*, No. 380, July 1935, pp. 129-153. (Coll. Park, Maryland).—Analysis of extensive data shows that the production of a ewe, as measured by the weight of lamb and wool produced, increases on an average with her size. When, however, production is measured by the returns per 100 lb. of ewe this advantage of the large ewe tends to disappear. It is pointed out that the latter method of measuring production is probably preferable since food consumption and cost of maintenance of a flock are proportional to total weight rather than to total numbers.

Interim Report of Pig Feeding Experiment conducted on the Cambridge University Farm during 1935. *W. S. Mansfield and W. R. Trehane. J. Roy. Agric. Soc. Engl.*, 1936, *96*, 137-148. (Univ. Farm, Cambridge).—A paired feeding experiment is described in which 40 pigs were individually fed to bacon weight (205 lb.). At 65 lb. live weight one pig in each pair continued to be fully fed, whilst the other received ¾ of this amount up to 100 lb. live weight and ⅘ thereafter.

The results indicate that although restricted feeding prolonged the feeding period by an average of 27 days (range 7-49 days), a greater economy was obtained in food consumption and a higher grade pig (as determined by the thickness of the back fat) was produced. The average food consumption for the unrestricted pigs was 3·60 lb. per lb. live weight increase compared with an average of 3·28 lb. for the restricted pigs. The results await confirmation.

Comparative Value of Soya Beans and of Meat Meal in Poultry Feeding. *M. S. Gutowska and J. Dreschерówna. Roczn. Nauk rol.*, 1936, *36*, 115-127. (Inst. Agric., Central Sch. Agronom., Warsaw). Two groups of White Leghorn chicks were fed for 6 weeks on well-balanced rations, one containing soya bean meal and the other meat meal in equivalent amounts. The protein content of the rations was 17 per cent. Growth in the groups was similar for 6¼ weeks, after which the group on the meat meal did better. It is concluded that soya bean meal can be used as a protein supplement in a growing ration, but it should be fortified with a mineral mixture and should be used in larger amounts than meat meal.

Potatoes in the Food Ration of Goslings. *A. B. Rabinovich. Problemy Zhivotnovodstva*, 1935, Nos. 4-5, 200-203.—With potatoes to the extent of 50 per cent of the ration of 2-months-old goslings, an economy of 22 per cent of concentrates was obtained. The increase in weight was less than with barley, but carcases had more fat, the smaller weight being due to a lower percentage of offal and water in the flesh; the edible parts, however, showed an increase of 12 per cent in Calorie value. Geese can consume relatively larger quantities of potatoes than can hens. Goslings of 2-3 months can eat 300-400 g. potatoes per day. Potatoes can also be fed to adult geese, but their fattening qualities and deficiency in protein and Na should be taken into account. Foodstuffs rich in protein should be fed along with the potatoes and care be taken that the geese do not get too fat during the laying period. Salt should also be added.

Bone Meal in the Feeding of Poultry. *M. S. Gutowska. Roczn. Nauk rol.*, 1936, *36*, 127-139. (Inst. Agric., Central Sch. Agronom., Warsaw). -The effect of adding to the ration of laying hens bone meal containing 17 per cent protein was studied for 9 months. Good results were obtained when the ration contained 2 per cent steamed bone meal, 3 per cent calcium carbonate and 1 per cent salt. The Ca : P ratio was 1:7 : 1. The addition of the steamed bone meal increased the average weight of the eggs, by increasing the weight of shell.

DAIRYING

Vitamin C in Pasteurised Milk. *Sharp.* 1936. *Science, 84*, 461-2.—Vitamin C (or ascorbic acid) content of fresh milk is relatively constant throughout the year, and is not materially affected by the seasonal food supply of the cow. But Vitamin C in milk may undergo progressive diminution by oxidation, this effect being brought about by an ascorbic acid oxidising enzyme, whose action is markedly accelerated by traces of dissolved copper. If the contamination of milk by copper from all sources is eliminated, milk pasteurised by the holding method may for all practical purposes be as potent in Vitamin C as raw milk. Only an insignificant amount of the Vitamin C is destroyed by heating in glass for 30 minutes at 145° F. If appreciable destruction of Vitamin C occurs during commercial pasteurisation, it is caused by copper contamination from the equipment. In seeking to eliminate this copper contamination, it is not sufficient to have only the main parts of the equipment of approved materials (such as glass-lined steel, aluminium or chromium steel containers); parts of the equipment which are often overlooked, such as thermometer couplings, valves, pumps, unions, pipes and bottling equipment must be free from copper and its alloys.

This investigation indicates that it is commercially feasible to pasteurise milk by the holding method, and maintain essentially as high an ascorbic acid (Vitamin C) content as that of raw milk of the same age. As the author remarks, this removes the main nutritional objection to pasteurised milk. Furthermore (since the enzyme which oxidises the ascorbic acid is destroyed by heating to 17° F for one-half minute or longer) it is possible by using higher temperatures to produce pasteurised milk which when subsequently held will exceed in ascorbic acid potency raw milk of the same age.

Certified Milk as a Source of Vitamin C. *Riddel and Whitnah.* 1936. *Milk Plant Monthly*, *25*, 48.—Fresh milk may be an important source of Vitamin C. Investigations by the authors show that the average content of Vitamin C in the milk of cows of the four major dairy breeds was 25·5 milligrams per litre, the milk samples having been taken directly from the milk pail and tested within four hours of production. As the Vitamin C requirement for the human adult is stated to be 27 milligrams per day, it appears that the consumption of one quart per day of such milk would furnish all the human needs for this vitamin. Unfortunately, Vitamin C is the least stable of the vitamins, being rapidly diminished by oxidation. Exposure of the freshly drawn milk to air in the straining and cooling processes may result in a loss of one-fifth of the Vitamin C at the end of 24 hours; exposure of the bottled milk to sunlight has also a diminishing effect. Certified milk should therefore be subjected to the minimum exposure to air during its production and handling, and the possibility of copper contamination—which increases the destructive oxidative effects on Vitamin C—eliminated. If in addition to a guaranteed sanitary quality, Certified Milk could also be guaranteed as to its Vitamin A potency, its Vitamin C content and other growth promoting properties, the demand for this high grade milk could not fail to be increased.

Removal of Sediment from Milk. *Fleming.* 1936. *Milk Plant Monthly*, *25*, 44-6.—Two methods of removing sediment from milk are in common use in milk depots, one employing the clarifier and the other the mechanical filter. The efficiency of the clarifier is indicated by the fact that it can remove from 99 to 99·6 per cent of the insoluble dirt, and from 39 to 67 per cent of the cellular content without appreciably diminishing the total solids of the milk, and without affecting the butter fat content, the flavour and keeping qualities. The disadvantages of the older type of clarifier (first introduced into milk plant practice in 1914) were foam formation at ordinary temperatures (*i.e.*, below 74° F), breaking up of bacterial clumps, and a perceptible reduction in the cream line. The foam produced by the clarifier is objectionable because foam interferes with efficient pasteurisation. On the other hand the mechanical filter does not produce foam and the cream line is not affected by its use. But after continuous use, the filter cloth becomes impregnated with sediment collecting on one side, with the result that after a two hours' run the milk passing through may have a largely increased bacterial count. From an operating standpoint, it is usually necessary to preheat the milk to be filtered to temperatures above 70° F in order to obtain sufficient capacity. This circumstance may lead to a rapid growth of the milk bacteria. Milk filtered at temperatures between 100° and 120° F for two hours or more becomes enriched in the heat resisting organism *Streptococcus thermophilus*; milk passing through filters at temperatures between 125° and 150° F contains high numbers of thermophilic bacteria. Because of these facts, it is advisable that milk should not be filtered at temperatures higher than 65° F. Improvements in the construction of the clarifier have entirely removed all its original defects. In the newer type of clarifier, the incorporation of air is prevented, resulting in the elimination of foam. By causing the milk to flow under pressure from the air-tight inlet to the discharge outlet, the breaking up of the bacterial clumps and the reduction of the cream line are overcome. Clarification can be accomplished at temperatures as low as 32° F, thus limiting the growth of bacteria in the milk.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS AND FERTILISERS IN SEPTEMBER, OCTOBER AND NOVEMBER 1936

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

Description	September			October			November		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*
Aberdeen Angus ...	44 7	40 8	38 4	43 9	40 0	37 4	44 9	40 9	37 10
Cross-bred (Shorthorn)	41 2	37 7	29 8	40 6	36 4	28 9	41 0	37 1	28 6
Galloway	40 11	37 10	...	38 2	35 5	...	38 6	35 3	..
Ayrshire	34 6	31 1	...	32 0	29 0	...	31 11	28 9	...
Blue Grey	43 3	40 7	39 2	42 6	39 6	...	43 1	40 0	...
Highland	...	...	...	...	...	...	..	...	...
	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
†VEAL CALVES	13	4¾	..	13	4½	...	13	4¾	...
†SHEEP—	Hoggs under 60 lb. per lb. *d.*	60 lb. and upw'd per lb *d.*	Ewes per lb. *d.*	Hoggs under 60 lb. per lb. *d.*	60 lb. and upw'd per lb. *d.*	Ewes per lb. *d.*	Hoggs under 60 lb. per lb. *d.*	60 lb. and upw'd per lb. *d.*	Ewes per lb. *d.*
Cheviot	11¼	10¼	6½	11	10	6¼	10¾	10	6¼
Half-bred	11¼	9¾	6¼	10¾	9¾	6	10¾	9½	5¾
Blackface	11¼	10	6½	10¾	9¾	6¼	10½	9½	6¼
Greyface	11¼	10¼	6¼	11	10	6	11	10	6
Down Cross	11½	10¼	6½	11	10	6	10¾	9¾	5¾
†PIGS—	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*
Bacon Pigs	9 4	8 3	...	9 5	8 4	...	9 6	8 6	...
Porkers	9 9	8 9	...	9 11	8 11	...	10 2	9 0	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK: Monthly Averages of Prices (per head) at certain representative Scottish Markets—(*continued*).

DESCRIPTION	SEPTEMBER			OCTOBER			NOVEMBER		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
CATTLE—									
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	14 15	12 0	9 14	14 18	12 4	9 16	14 14	12 4	9 6
Two-year-olds ...	18 17	15 8	12 13	18 12	15 12	12 6	18 12	15 3	11 13
Cross-bred (Shorthorn)									
Yearlings	13 15	11 10	9 16	13 16	11 5	9 18	13 18	11 10	9 14
Two-year-olds ...	18 1	15 2	13 8	17 16	14 15	12 15	17 19	14 19	12 8
Galloway:									
Yearlings	12 11	10 5	...	13 15	10 13	...	13 11	10 15	...
Two-year-olds ...	18 5	14 3	...	17 10	14 2	...	...	15 15	...
Ayrshire:									
Yearlings	10 13	9 0	...	11 15	9 10	...	11 16	10 7	...
Two-year-olds ...	13 5	...	...	16 0	...	...	...	...	...
Blue Grey:									
Yearlings	13 0	...	...	13 0	...	...	...	...	..
Two-year-olds ...	...	...	...	...	...	...	..	...	...
Highland:									
Yearlings	8 10	7 10	6 5	8 13	7 5	5 10	...	7 0	...
Two-year-olds ...	10 18	9 10	8 0	10 15	9 14	8 15	...	...	...
Three-year-olds ...	...	...	...	14 8	13 4	11 18	...	...	...
DAIRY COWS—									
Ayrshire:									
In Milk	27 15	19 6	13 7	28 3	19 12	13 15	29 9	20 6	13 14
Calvers	27 13	20 2	14 14	27 4	20 6	14 14	28 17	20 8	14 17
Shorthorn Cross:									
In Milk	26 9	19 3	17 12	26 18	19 6	17 18	28 1	19 14	18 10
Calvers	26 18	17 18	16 17	26 8	17 12	16 11	26 9	17 17	15 8
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	...	..	...	48 0	...	...	...	...	...
Half-bred Hoggs ...	46 0	...	...	...	...	...	...	...	...
Blackface Hoggs ...	34 0	...	...	30 9	21 5	...	28 9	20 9	...
Greyface Hoggs ...	..	...	...	42 0	34 4	...	42 0	33 6	...
Down Cross Hoggs	...	...	...	51 6	42 0	...	45 8	38 4	...
PIGS—									
(6 to 10 weeks old)	34 2	23 8	...	35 0	24 8	...	34 7	23 8	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	SEPTEMBER			OCTOBER			NOVEMBER		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF :—										
Home-fed—										
Bullock or Heifer ...	1	7	7	7⅞	7	6⅜	7⅝	6⅞	6⅛	7⅞
	2	6¾	...	7	6¼	...	6⅞	6	...	7
Bull	1	5½	4¾	5	5½	4¾	5	5½	4⅞	5
	2	5	...	4	5	...	4	5	...	4
Cow	1	5	4⅝	5	4⅝	4⅝	5	4½	4½	5
	2	4½	...	4	4⅛	...	4	4	...	4
Irish—										
Bullock or Heifer ...	1	...	..	7⅛	...	...	6⅞	..	...	7⅛
	2	...	...	6¼	...	...	6	...	...	6¼
Argentine Frozen—										
Hind Quarters ...	1	...	4⅜	...	...	4⅜	...	...	4¼	...
	2	...	3⅞	...	...	4	...	...	3¾	...
Fore ,, ...	1	...	3⅜	...	...	3¼	...	.	3¼	...
	2	...	2⅞	...	...	2⅞	...	...	3	...
Argentine Chilled—										
Hind Quarters ...	1	6⅜	6¾	6	6⅛	6½	5⅞	5⅞	6⅜	6⅛
	2	...	6⅛	5½	...	6	5½	5¼	5⅞	5½
Fore ,, ...	1	3¾	4	3¾	3¾	4	3½	3¾	4	3¾
	2	...	3⅝	3⅜	...	3½	...	3¼	3⅝	...
Australian Frozen—										
Hind Quarters ...	1	4	..	3⅞	4	...	3⅞	3⅞	...	3⅞
	2	...	...	...	...	...	...	...	...	...
Crops	1	3	.	2⅞	3	...	2⅞	2⅞	...	2⅞
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	4	...	3⅞	4	...	3⅞	3⅞	..	3⅞
	2	...	...	...	...	...	...	...	...	..
Fore ,, ...	1	3	...	2¾	3	.	2¾	2⅞	...	2¾
	2	...	...	...	...	...	...	...	..	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	12	10⅜	10¼	11¼	10¼	10⅛	11	9⅞	10
	60 lb. & over	11	...	9¾	10¼	...	9⅝	10	...	9½
,, Cross ...	under 60 lb.	12	10⅜	10¼	11¼	10¼	10⅛	11	9⅞	10
	60 lb. & over	11	...	9¾	10¼	..	9⅝	10	...	9½
Ewes, Cheviot ...	1	...	6⅝	6¼	...	6⅛	5¾	...	6	5⅞
	2	...	...	5¾	...	...	5¼	...	...	5½
,, Blackface ...	1	7½	6⅝	6¼	6⅜	6⅛	5¾	6¼	6	5⅞
	2	6½	...	5¾	5⅜	...	5¼	5¼	...	5½
,, Cross	1	6	6⅝	5½	4½	6⅛	5⅜	4½	6	5½
	2	5	...	5	...	...	5	4	...	5
Argentine Frozen ...	1	...	...	3¾	...	...	3¾	...	...	3¾
	2	...	...	...	..	...	...	...	...	...
Australian ,, ...	1	...	5⅜	3¾	...	5¼	3¾	...	5	3¾
	2	...	4½	...	...	3¾	...	...	3¾	...
New Zealand ,, ...	1	...	...	4⅜	...	...	4⅜	...	...	4⅜
	2	..	...	4	.	...	4	...	...	3¾
LAMB :—										
Home-fed	1	12	11⅞	11⅜	...	10⅝	11	...	9⅞	10¾
	2	...	...	10⅞	...	...	10⅜	...	...	10
New Zealand Frozen	1	...	7¾	7⅛	...	7⅞	7⅛	...	8	7⅛
	2	...	6⅞	..	...	6⅞	...	...	7⅛	...
Australian ,, ...	1	.	...	6⅜	...	...	6⅜	...	...	6⅛
	2	...	...	...	...	...	..	...	...	...
Argentine ,, ...	1	...	...	6¼	...	...	6¼	...	...	6¼
	2	...	...	...	..	...	...	...	...	..
		per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
PORK :—										
Home-fed	1	74 8	77 0	79 4	81 8	79 4	75 0	84 0	79 4	79 4
	2	37 4	...	70 0	37 4	...	71 9	46 8	...	72 4
Imported	1	...	...	56 0	...	...	61 3	...	...	63 0

EGGS: Monthly Average Wholesale Prices at Aberdeen Kilmarnock, Lanarkshire and Glasgow.

(Compiled from returns received from the Department's Market Reporters)

DESCRIPTION	WEIGHT PER 120	QUALITY	SEPTEMBER	OCTOBER	NOVEMBER
	lb.		s. d.	s. d.	s. d.
ABERDEEN—					
Country (ungraded) per doz.	...	1	1 3	1 9	1 10¾
	...	2	1 2½	1 6½	1 10½
KILMARNOCK—					
Country (ungraded) per doz.	...	1	1 7½	2 1	2 3
LANARKSHIRE—					
Country "Standards" per doz.	...	1	1 9½	2 4	2 6¾
GLASGOW—					
Unstamped Scottish Eggs ... per doz.	...	1	1 8½	2 2	2 4
National Mark—					
"Specials" .. ,,	...	...	1 9	2 3½	2 3½
"Standards" ... ,,	...	...	1 7¾	2 2	2 1¾
"Mediums" ... ,,		...	1 4¾	1 11	1 10½
Ungraded ... ,,	..	1	1 5¼	1 11	1 11¼
"Specials" ... per 120	...	.	17 2	22 11	22 10
"Standards" ... ,,	...	..	16 3	21 9	21 4
"Mediums" ... ,,	...	...	13 11	19 5	18 9
Ungraded ... ,,	..	1	14 2	19 3	19 5
Northern Ireland ,,	17	...	16 7	21 11	21 6
,, ,,	15½	..	15 8	20 11	20 6
,, ,,	14	..	13 5	18 9	18 0
,, (Duck) ,,	...	1	11 8	12 5	...
Irish Free State ... ,,	16	...	14 1	16 7	19 6
,, ... ,,	15	...	13 1	15 9	18 8
,, ,,	14	...	11 8	13 9	16 5
,, (Duck) ,,	.	1	11 3	11 9	13 8
Danish ... ,,	17	...	13 7	15 8	17 5
,, ... ,,	15½	...	12 10	15 1	16 11
,, ... ,,	14	...	12 2	14 2	14 7
Swedish ... ... ,,	17	...	12 9	15 1	...
,, ... ,,	15½	..	12 6	14 5	...
,, ... ,,	14	...	11 8	13 5	...
Australian .. ,,	17	...	...	15 0	..
,, ... ,,	16	...	...	14 9	14 8
,, ... ,,	14	...	...	13 9	13 6
Polish ("Blue")... ,,	...	...	7 5	8 6	8 6

PROVISIONS: Monthly Average Wholesale Prices (per cwt.) at Glasgow.

DESCRIPTION	QUALITY	SEPTEMBER	OCTOBER	NOVEMBER
		s. d.	s. d.	s. d.
BUTTER—Scot. Creamery (uns'lt'd)	1	125 2	118 3	121 6
Irish Creamery	1	114 7	104 9	112 6
,, ,, (unsalted) ...	1	116 7	107 9	112 0
Australian	1	113 7	103 8	113 0
New Zealand	1	113 10	104 0	112 0
Danish	1	129 7	126 6	127 0
,, (unsalted) ..	1	132 10	129 0	130 0
Dutch	1	108 7	98 9	104 9
Latvian	1	112 2	100 6	104 6
Swedish	1	119 10	116 0	115 8
CHEESE—Cheddar	1	78 5	82 0	85 0
	2	62 2	73 9	73 6
Dunlop	1	78 5	86 0	86 0
	2	71 7	79 6	79 6
Canadian	1	74 0	74 0	75 6
New Zealand (Coloured) ..	1	71 10	70 0	74 6
,, (White) ...	1	75 7	70 0	74 6
*FARMHOUSE CHEESE—				
Coloured Cheddar ...	..	72 7	72 11	75 0
White Cheddar	...	72 6	72 11	76 0
Dunlop	..	73 1	72 11	75 3
Cheshire .. ..per lb.	...	0 6¼	0 6⅝	0 7⅜
*FACTORY CHEESE—C'l'r'd Cheddar	...	70 0	68 6	68 7
White Cheddar	...	70 0	69 5	69 6
Dunlop	...	73 6	73 6	73 6
HAMS—Irish (Smoked)	1	162 0	162 0	142 0
	2	147 0	142 0	122 0
,, (Boneless)	1	126 0	119 0	116 0
American (Short Cut, Green) ..	1	98 0	97 0	99 0
	2	86 0	88 0	...
BACON—Ayrshire (Rolled) ...	1	126 6	121 4	121 4
English Wiltshire (Green) ..	1	101 10	97 0	95 0
,, (Dried or Smoked ...	1	109 0	105 0	103 0
Irish (Green, Wiltshire Style) ...	1	103 10	99 6	95 0
	2	95 7	94 0	91 0
,, (Dried or Smoked) ..	1	109 10	105 6	101 0
	2	101 7	97 0	93 0
,, (Long Clear, rolled with skin on).	1	120 7	116 0	113 0
Canadian Sides (Green) ...	1	...	94 9	87 0
Danish Sides	1	111 0	109 6	101 0
Dutch (Green, Wiltshire Style)	1	104 0	110 6	102 0
LARD—American	1	72 2	68 6	68 9

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* Farmhouse and Factory Cheese Prices quoted are as supplied by the Scottish Milk Marketing Board in respect of Cheese supplied to Brokers.

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter)

DESCRIPTION		QUALITY	SEPTEMBER	OCTOBER	NOVEMBER
FRUIT:—					
Apples—					
British—	per		*s. d.*	*s. d.*	*s. d.*
Cooking	56 lb.	1	5 1	5 6	5 4
American	case.*	1	13 4	11 9	12 6
	barrel**	1	40 0	28 10	23 6
New Zealand	case.*	1	8 0	...	...
Pears—					
Californian	case.*	1	16 7	13 5	13 11
Gooseberries	lb.	1	0 2¼	...	...
Blackberries	,,	1	0 5¼	0 4¼	...
Damsons	,,	1	0 1¾	0 1¾	...
Greengages	,,	1	0 3	...	...
Plums—					
Egg	,,	1	0 1	...	...
Monarch	,,	1	0 1¼	...	..
Prolific	,,	1	0 1½	0 1⅛	...
Victoria	,,	1	0 2	0 2½	...
VEGETABLES:—					
Beans, Dwarf	,,	1	0 2½	...	...
Beet	cwt.	1	6 2	5 6	5 0
Brussels Sprouts—					
English	net 20 lb.	1	4 6	4 10	3 0
Cabbage—					
Coleworts	dozen.	1	1 7	1 3	1 2
Red	,,	1	3 0	2 9	3 0
Savoy	,,	1	...	2 0	1 8
Carrots—					
British	cwt.	1	5 6	5 0	5 0
Cauliflowers—					
British	dozen.	1	1 10	4 3	4 11
Celery	bunch.	1	1 5	1 6	1 6
Cucumbers	dozen.	1	4 0	4 0	10 3
Greens	bunch.	1	0 6	0 6	0 6¼
Leeks	dozen bunches.	1	2 10	2 6	2 6
Lettuce—					
Cos	dozen.	1	1 1	0 11	...
Cabbage	,,	1	1 2	1 1	1 3
Onions—					
Spring	bunch.	1	0 6½	0 6½	0 6¼
Dutch	cwt.	1	6 1	5 8	5 8
Hungarian	,,	1	7 0	7 6	7 3
Valencia	case.**	1	13 0	10 6	12 4
Parsley	cwt.	1	13 7	12 0	12 0
Parsnips	,,	1	8 7	8 9	8 0
Peas	,,	1	5 7	...	...
Radishes	dozen bunches.	1	1 8	1 5	1 6
Rhubarb	cwt.	1	5 0	4 0	...
Spinach	stone.	1	2 4	3 0	2 0
Tomatoes—					
Scottish	lb.	1	0 5	0 6¾	0 7¼
Canary	,,	1	...	...	0 3¾
Channel Islands	,,	1	0 3	0 4¼	0 4¼
Dutch	,,	1	..	0 4	0 3¾
Turnips	cwt.	1	2 5	1 11	1 9
Vegetable Marrow	dozen.	1	5 5	4 6	4 0

* 40 lb. (approx.). ** 9 stone (approx.).

POTATOES: Monthly Average Wholesale Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	SEPTEMBER		LATE VARIETIES			
		FIRST EARLIES	SECOND EARLIES	RED SOILS		OTHER SOILS	
				Golden Wonder	Other	Golden Wonder	Other
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Aberdeen ...	1	...	4 7 0	...	...	...	...
Dundee ...	1	3 17 6	3 18 0	...	...	...	4 0 0
Edinburgh ..	1	...	3 10 0	...	...	...	...
Glasgow ..	1	2 16 8	4 6 3	...	...	...	4 8 4
				OCTOBER			
Aberdeen ...	1	..	..	..	...	...	4 0 0
Dundee ...	1	...	...	...	...	...	4 4 5
Edinburgh ...	1	...	4 6 8	..	..	...	4 6 8
Glasgow ...	1	...	3 18 9	...	. .	...	4 7 6
				NOVEMBER			
Aberdeen ...	1	...	...	...	...	...	4 5 0
Dundee ...	1	...	...	...	...	...	4 18 9
Edinburgh ..	1	...	4 11 8	..	...	...	4 11 3
Glasgow ...	1	...	4 12 6	...	...	...	4 18 9

ROOTS, HAY, STRAW AND MOSS LITTER: Monthly Average Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	SEPTEMBER								
		ROOTS			HAY		STRAW			MOSS LITTER
		Carrots	Yellow Turnips	Swedes	Rye Grass and Clover	Timothy	Wheat	Barley	Oat	
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
*Aberdeen ...	1	...	...	...	68 0	...	...	...	24 0	...
†Dundee ...	1	...	20 9	...	120 0a 109 0b	...	57 0	...	60 0	...
‖Edinburgh ...	1	...	...	...	80 0b	...	35 0	30 0	37 6	...
aGlasgow ...	1	...	...	...	94 0	99 0	52 0	...	52 0	32 6c
					OCTOBER					
*Aberdeen ...	1	...	..	...	75 0	...	..	...	25 0	...
†Dundee ...	1	...	17 0	...	120 0a 110 0b	...	60 0	...	65 0	...
‖Edinburgh ...	1	...	...	...	85 0b	...	37 6	32 6	38 2	...
aGlasgow ...	1	...	...	...	95 0	100 0	55 0	...	55 0	32 6c
					NOVEMBER					
*Aberdeen ...	1	...	...	...	75 0	. .	...	...	25 0	...
†Dundee ...	1	...	14 0	17 9	120 0a 110 0b	...	61 3	...	65 8	...
‖Edinburgh ...	1	...	...	...	90 0a 90 0b	...	40 0	35 0	40 0	...
aGlasgow ...	1	...	...	...	95 0	100 0	56 3	...	56 3	32 6c

* Ex farm, loose.

† Baled straw, delivered in town.

‖ Bunched or baled straw, delivered.

a Baled and delivered.

b Delivered, loose.

c Home moss litter, in 1½-cwt. bales.

FEEDING STUFFS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	SEPTEMBER		OCTOBER		NOVEMBER	
	Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Linseed Cake—						
Home	9 1 0	9 0 0	8 17 2	8 15 0	8 12 6	8 11 3
Foreign	8 10 3	..	8 9 8	..	8 9 5	..
Decort. Cotton Cake ...	8 2 6	7 17 6	8 3 9	8 0 0	8 1 11	8 0 0
Undecort. Cotton Cake—						
Egyptian (Home manufactured)	5 16 9	5 13 6	5 13 2	5 10 0	5 13 9	5 11 8
Palmnut Kernel Cake . .	8 0 0	...	8 0 0	...	8 0 0	..
Groundnut Cake, undecort.—						
(50% Oil and Album.)	8 1 6		8 2 6	..	8 1 11	...
(54% ,, ,,)	8 3 6	.	8 5 0	..	8 4 5	.
Maize Germ Cake, Home mfd.	7 15 0	...	7 9 5	..	7 4 1	...
Rice Meal	6 0 6	5 10 0	6 0 8	5 11 3	6 0 0	5 12 6
Maize Germ Meal (African)	6 16 0	.	6 19 1	..	6 19 5	..
Bean Meal	8 4 5	8 4 0	8 1 11	8 4 5	7 19 1	8 3 9
Fish Meal	14 3 0	14 3 0	14 9 5	14 10 0	14 10 0	14 10 0
Maize Meal—						
Home manufactured ...	7 2 3	6 15 6	6 19 1	6 13 9	6 10 11	6 10 0
South African, Yellow ...	7 2 6	.	6 19 2	. .		..
,, ,, Mixed ..	6 16 3	. .	6 17 6	...	.	..
Barley Meal	8 0 0	7 8 9	8 9 5	8 0 0	8 4 5	8 0 0
Locust Bean Meal ...	7 5 0	7 10 0	7 5 0	7 10 0	7 7 6	7 10 0
Locust Beans (Kibbled and Stoned)	6 5 0	6 4 6	6 6 7	6 1 3	6 0 11	6 3 4
Maize Gluten Feed (Paisley)	6 0 0	...	6 17 6	...	7 0 0	..
Maize—						
Plate	6 3 9	5 18 6	6 0 4	5 16 3	5 12 6	5 9 5
African	7 5 0	...	7 8 4	...	7 10 0	...
Oats—						
Home	7 3 0	7 5 0	7 18 2	7 6 3	8 0 0	7 1 3
Barley—						
Imported	7 2 0	6 13 0	7 5 0	7 8 2	7 5 8	7 2 6
Malt Culms	5 11 0	4 12 6	5 13 2	4 15 0	5 17 8	4 15 0
Brewer's Grains (dried) ...	6 3 0	5 11 0	6 6 3	5 13 9	6 6 7	5 15 0
Distillers' Malt Grains (dried)	6 7 6	. .	6 15 8	..	6 15 0	.
Distillers' Mixed Grains (dried)	6 10 0	...	6 19 5	..	6 15 0	..
Wheat—						
Home	8 19 0	8 6 0	8 11 11	8 13 2	9 2 6	8 15 0
,, (Poultry)	8 17 6	...	8 16 8	...	8 12 6	..
Middlings (Fine Thirds or Parings)	7 9 0	7 5 0	7 15 4	7 6 11	7 11 7	7 4 8
Sharps (Common Thirds)	6 9 9	6 9 6	6 19 1	6 13 9	6 17 2	6 15 0
Bran (Medium)	6 10 0	6 14 6	6 19 5	6 15 0	6 17 10	6 13 9
,, (Broad)	7 0 3	7 8 6	7 6 11	7 9 5	7 4 1	7 6 11
Feeding Treacle	5 5 6	6 0 0	5 7 6	6 0 0	5 7 6	6 0 0
Crushed Linseed	16 10 0	...	16 10 0	...	17 0 0	...
Beans—						
China	7 6 3	7 0 0	7 4 1	7 0 0	7 0 4	6 17 6
Rangoon (White)	...	...	6 12 6	...	6 11 8	...
Peas—						
Karachi (White)	8 15 0	...	8 15 0	...	...	...
Sugar-Beet Pulp (English)	...	6 7 6	...	6 7 6	6 18 9	6 7 6
Linseed Oil, per gall. ...	0 4 0	...	0 4 0	...	0 4 0	...

FERTILISERS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	Guaranteed Analysis	SEPTEMBER						OCTOBER						NOVEMBER					
		Glasgow			Leith			Glasgow			Leith			Glasgow			Leith		
	%	£	s.	d.	£	s.	d	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Nitrate of Soda*	N. 15 5	7	12	6	7	12	6	7	12	6	7	12	6	7	12	6	7	12	6
Sulphate of Ammonia (Neutral and Granular)*	N 20.6	6	16	0	6	19	7	6	17	6	6	17	6	6	19	0	6	19	0
Calcium Cyanamide†	N. 20.6	6	16	3	7	1	3	6	17	6				6	18	9		.	
Nitrochalk*	N. 15.5	7	5	0	7	5	0	7	5	0	7	5	0	7	5	0	7	5	0
Superphosphate	P.A. 13 7	2	12	6	2	12	6	2	12	6	2	12	6	2	12	6	2	12	6
,,	,, 16 0	2	17	6	2	17	6	2	17	6	2	17	6	2	17	6	2	17	6
,,	,, 18 3	3	2	6	3	2	6	3	2	6	3	2	6	3	2	6	3	2	6
Ground Mineral Phosphate §	P A. 26	2	12	6	2	11	6	2	12	6	2	12	6	2	12	6	2	12	6
,, ,, ,, §	,, 34				3	10	0												
Potassic Mineral Phosphate	P.A. 18 Pot 9				3	11	3				3	11	3				3	11	3
,, ,, ,,	P.A 18 Pot. 10	3	16	3	3	12	6	3	16	3				3	16	3			
,, ,, ,,	P.A. 20 Pot. 7 5	3	11	3				3	11	3				3	11	3			
,, ,, ,,	P.A. 21 Pot. 6				3	6	3				3	6	3				3	6	3
,, ,, ,,	P.A 21 Pot. 10				3	17	6				3	17	6				3	17	6
Kainit (in bags)	Pot. 14	3	1	3	3	0	0	3	1	3	3	0	0	3	1	3	3	0	0
Potash Salts	Pot 20	4	2	6	4	0	0	4	2	6	4	0	0	4	2	6	4	0	0
,, ,,	,, 30	5	1	3	4	15	0	5	1	3	4	15	0	5	1	3	4	15	0
Muriate of Potash (on basis of 80 per cent purity)	Pot. 50	8	2	6	7	15	0	8	2	6	7	15	0	8	2	6	7	15	0
Sulphate of Potash (on basis of 90 per cent purity)	Pot. 48.6	9	13	6	9	7	6	9	15	0	9	7	6	9	15	0	9	7	6
Steamed Bone Flour	N. 0 8 P.A 28	5	7	6	5	5	0	5	7	6	5	5	0	5	7	6	5	5	0
Bone Meal (Indian)	N. 4 P.A 20	6	12	6	6	9	6	6	12	6	6	12	6	6	12	6	6	12	6
Basic Slag‡	P.A 12	2	5	0	1	18	6	2	5	0				2	5	0		.	
,, ,,	,, 13	2	7	0	1	16	10	2	7	0	1	14	6	2	7	0	1	14	6
,, ,,	,, 14	2	9	0	1	18	11	2	9	0	1	16	6	2	9	0	1	16	6
,, ,,	,, 15				2	10	0				2	10	0				2	10	0
Potassic Slag	P.A. 12 Pot. 6				3	7	0				3	10	0		.		3	10	0

Abbreviations:—N. = Nitrogen; P.A. = Phosphoric Acid; Pot. = Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

§ Fine grist, 90 per cent fineness through prescribed sieve.

‡ Basic Slag: At Glasgow—80 per cent citric soluble and 80 per cent fineness; F.o.r., in 6-ton lots.

At Leith—Non-citric soluble, 80 per cent fineness. *Ex* Middlesborough; carriage paid in 6-ton lots to stations in Berwickshire and Roxburghshire; carriage paid to Mid and East Lothian 2s. 6d. extra.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1936

Collected 4th June 1936 (and comparison with 1935)

CROPS

DISTRIBUTION	1936	1935	INCREASE		DECREASE	
	Acres	*Acres*	*Acres*	*Per Cent*	*Acres*	*Per Cent*
TOTAL AREA (excluding WATER)	19.069.000	19.069,000	..	..	..	..
MOUNTAIN AND HEATH LAND used for GRAZING (*a*)	10,410,692	10,383,100	27,592	0·3	..	..
TOTAL ACREAGE under CROPS and GRASS	4,592,377	4,598,547	..	..	6,170	0·1
ARABLE LAND	2,975,995	2,982,911	..	..	6,916	0·2
PERMANENT GRASS (*b*) { For Hay	170,322	178,781	..	..	8,459	4·7
PERMANENT GRASS (*b*) { Not for Hay ..	1,446,060	1,436,855	9,205	0·6	..	..
TOTAL	1,616,382	1,615,636	746	0·5	..	..
Wheat	93,742	100,744	..	..	7,002	7·0
Barley (including Bere)	72,233	76,513	..	..	4,280	5·6
Oats	828,780	826,908	1,872	0·2	..	..
Mixed Grain	2,316	1,909	407	21·3	..	..
Rye	2,547	2,697	..	..	150	5·6
Beans	2,806	3,189	..	..	383	12·0
Peas	805	774	31	4·0	..	..
Potatoes	133,057	131,596	1,461	1·1	..	..
Turnips and Swedes	345,871	352,175	..	..	6,304	1·8
Mangolds	3,202	2,409	793	32·9	..	..
Sugar Beet	6,762	7,449	..	..	687	9·2
Cabbage	5,327	6,096	..	..	769	12·6
Rape	11,128	11,020	108	1·0	..	..
Vetches or Tares, for Seed	146	119	27	22·7	..	..
Vetches, Tares, Mashlum, etc., for Fodder ..	6,582	7,363	..	..	781	10·6
Carrots	770	666	104	15·6	..	..
Onions	131	132	..	..	1	0·8
Flax	288	20	268	1340·0	..	.
Small Fruit	9,461	9,547	..	..	86	0·9
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER { For Hay ..	396,679	396,423	256	0·1	..	..
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER { Not for Hay	1,033,375	1,024,031	9,344	0·9	..	..
TOTAL	1,430,054	1,420,454	9,600	0·7	..	..
OTHER CROPS	7,318	7,192	189	2·6	..	..
BARE FALLOW	12,606	13,939	..	..	1,333	9·6
ORCHARDS (*b*)	1,240	1,165	75	6·4	..	..

LIVE STOCK

	No.	*No.*	*No.*	*Per Cent*	*No.*	*Per Cent*
Horses used for Agricultural Purposes (including Mares for Breeding)	110,391	110,554	..	..	163	0·2
Unbroken Horses (including Stallions) { One year and above	16,650	15,967	683	4·3	..	..
Unbroken Horses (including Stallions) { Under one year ..	6,537	6,144	393	6·4	..	..
TOTAL	133,578	132,665	913	0·7	..	..
Other Horses	13,578	14,329	..	..	751	5·2
TOTAL OF HORSES	147,156	146,994	162	0·1	..	..
Cows in Milk	368,491	370,782	..	..	2,291	0·6
Cows in Calf, but not in Milk	55,887	55,825	62	0·1	..	..
Heifers in Calf	70,678	70,631	47	0·1	..	..
Bulls being used for Service	17.018	17,612	..	..	594	3·4
Other Cattle :—Two years and above ..	195,533	195,222	311	0·2	..	..
,, ,, One year and under two ..	331,537	329,731	1,806	0·5	..	..
,, ,, Under one year	273,904	278,691	..	..	4,787	1·7
TOTAL OF CATTLE (*c*) ..	1.313.048	1.318,494	..	..	5,446	0·4
Ewes kept for Breeding	3,310.331	3,340,658	..	..	30,327	0·9
Rams to be used for Service in 1936	96,698	96,117	581	0·6	..	..
Other Sheep :—One year and above	877,278	941,550	..	..	64,272	6·8
,, ,, Under one year	3,273,090	3,388,090	..	..	115,000	3·4
TOTAL OF SHEEP (*c*) ..	7,557,397	7,766,415	..	..	209,018	2·7
Sows kept for Breeding	28,917	31,993	..	..	3,076	9·6
Boars being used for Service	2,845	3,056	..	..	211	6·9
Other Pigs	204,622	225,164	..	..	20,542	9·1
TOTAL OF PIGS	236,384	260,213	..	..	23,829	9·2

(*a*) Includes Land in Deer Forests used or capable of being used or grazing.

(*b*) Any Crop or Grass grown in Orchards is also returned under its proper heading.

(*c*) Including cattle and sheep grazed on Deer Forests.

POULTRY.

DISTRIBUTION	1936	1935	INCREASE		DECREASE	
	No.	*No.*	*No.*	*Per cent*	*No.*	*Per cent*
FOWLS:—						
Over six months old ...	3,780,178	3,793,162	...	...	12,984	0·3
Under six months old ...	4,174,322	3,995,441	178,881	4·5	...	...
DUCKS:—						
Over six months old ...	147,521	155,609	...	...	8,088	5·2
Under six months old ...	88,545	99,097	..	...	10,552	10·6
GEESE:—						
Over six months old ...	8,722	} * 23,758	2,399	10·1	...	...
Under six months old ...	17,435					
TURKEYS:—						
Over six months old ...	16,129	} * 81,618	15,219	18·6	...	...
Under six months old ...	80,708					
TOTAL POULTRY	8,313,560	8,148,685	164,875	2·0	...	...

Age distribution was not ascertained in 1935.

LABOUR.

DISTRIBUTION	1936	1935	INCREASE		DECREASE	
	No.	*No.*	*No.*	*Per cent*	*No.*	*Per cent*
REGULAR WORKERS:—						
Males 21 years old and over	59,707	60,118	...	...	411	0·7
Males under 21 years old ...	19,909	19,633	276	1·4	...	...
Women and Girls	16,430	17,816	...	...	1,386	7·8
TOTAL	96,046	97,567	...	...	1,521	1·6
CASUAL WORKERS:—						
Males 21 years old and over	6,370	6,825	...	...	455	6·7
Males under 21 years old ...	2,787	2,978	...	...	191	6·4
Women and Girls	5,414	6,093	...	...	679	11·1
TOTAL	14,571	15,896	...	...	1,325	8·3
TOTAL LABOUR	110,617	113,463	...	...	2,846	2·5

ACREAGE under WHEAT, BARLEY (including BERE) and OATS in each COUNTY on 4th June 1936, with COMPARISON for 1935.

COUNTIES	Wheat		Barley (including Bere)		Oats	
	1936	1935	1936	1935	1936	1935
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
ABERDEEN ..	182	198	6,475	8,809	178,648	177,352
ANGUS ...	17,425	19,054	5,095	5,792	53,844	52,366
ARGYLL	6	10	462	555	13,299	12,950
AYR	1,688	1,858	19	40	31,992	31,994
BANFF	85	47	5,216	5,352	43,080	43,163
BERWICK	7,701	7,289	7,801	7,503	20,519	21,906
BUTE	..	2	2	3	3,948	3,949
CAITHNESS	3	17	339	404	24,230	24,450
CLACKMANNAN ...	269	341	19	36	2,532	2,475
DUMFRIES	582	671	32	19	31,185	31,298
DUNBARTON	491	668	5	6	5,430	5,436
EAST LOTHIAN ...	7,659	9,105	12,293	10,847	11,167	11,633
FIFE	17,445	18,527	6,417	6,983	36,667	35,596
INVERNESS	257	286	2,622	2,936	27,405	27,518
KINCARDINE	2,870	3,160	2,755	3,326	30,590	30,366
KINROSS	666	678	60	131	5,688	5,733
KIRKCUDBRIGHT ...	410	385	43	125	18,822	18,698
LANARK	2,576	2,977	37	38	32,284	32,055
MIDLOTHIAN	6,248	6,780	2,625	2,131	16,454	16,672
MORAY	3,015	2,176	6,296	6,786	21,765	22,150
NAIRN	260	132	1,285	1,493	6,266	6,205
ORKNEY	..		2,139	2,335	29,180	28,987
PEEBLES	5	13	45	41	5,118	5,192
PERTH	11,365	12,781	979	1,067	57,063	56,852
RENFREW	1,714	1,855	3	1	7,081	7,251
ROSS AND CROMARTY	1,512	1,770	3,969	4,290	31,286	31,205
ROXBURGH	4,020	3,524	3,568	3,834	19,584	20,457
SELKIRK	3	3	18	20	3,456	3,463
STIRLING	1,920	2,666	132	189	15,366	14,915
SUTHERLAND	...	7	124	152	6,142	6,242
WEST LOTHIAN ...	3,101	3,485	941	781	8,875	8,700
WIGTOWN	264	279	7	79	24,211	23,980
ZETLAND	..	..	410	409	5,603	5,699
TOTAL ...	93,742	100,744	72,233	76,513	828,780	826,908

Acreage under Potatoes, Turnips and Swedes and Sugar Beet in each County on 4th June 1936, with Comparison for 1935.

Counties	Potatoes		Turnips and Swedes		Sugar Beet	
	1936	1935	1936	1935	1936	1935
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Aberdeen	7,035	6,962	76,677	76,995	1	15
Angus	18,917	18,628	26,271	26,867	879	960
Argyll	1,885	1,925	4,110	4,234	...	...
Ayr	7,530	7,702	6,287	6,574	4	4
Banff	1,520	1,492	17,640	18,019	7	8
Berwick	2,172	2,040	15,816	15,927	499	398
Bute	901	863	1,128	1,139	...	...
Caithness	892	915	9,389	9,376	..	...
Clackmannan ...	339	357	680	682	...	...
Dumfries	2,517	2,549	13,247	13,623	19	13
Dunbarton	2,015	1,955	1,143	1,157	5	4
East Lothian ...	7,844	7,718	9,698	9,886	501	571
Fife	15,383	15,308	16,729	17,143	3,491	3,786
Inverness	4,192	4,212	7,741	7,940	32	49
Kincardine	4,096	3,981	13,941	14,173	69	144
Kinross	1,185	1,161	2,012	2,138	1	9
Kirkcudbright ...	1,114	1,093	8,401	8,510	...	...
Lanark	5,931	5,845	8,423	8,703	3	5
Midlothian	5,522	5,497	7,415	7,750	82	61
Moray	1,557	1,506	12,004	12,212	437	427
Nairn	253	249	3,426	3,584	40	52
Orkney	1,678	1,686	11,615	11,981	...	...
Peebles	278	272	2,476	2,389	...	...
Perth	17,614	17,117	20,739	21,250	462	642
Renfrew	2,751	2,729	1,750	1,805	...	...
Ross and Cromarty	6,599	6,653	12,275	12,656	58	128
Roxburgh	1,408	1,383	13,704	13,982	91	88
Selkirk	120	131	1,812	1,889	...	...
Stirling	3,055	2,917	3,191	3,359	3	12
Sutherland	829	858	2,227	2,261	...	...
West Lothian ...	2,405	2,384	2,640	2,700	13	16
Wigtown	1,764	1,712	10,248	10,279	65	57
Zetland	1,756	1,796	1,016	992	...	...
Total ...	133,057	131,596	345,871	352,175	6,762	7,449

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1936, with COMPARISON for 1935.

COUNTIES.	Rye-Grass and other Rotation Grasses and Clover				Permanent Grass			
	For Hay		Not for Hay		For Hay		Not for Hay	
	1936	1935	1936	1935	1936	1935	1936	1935
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
ABERDEEN ...	55,323	55,308	233,337	231,915	2,312	2,779	55,845	56,112
ANGUS	20,776	22,357	62,320	57,141	1,746	1,996	30,744	33,594
ARGYLL	10,457	10,819	13,237	13,892	15,013	15,112	49,676	49,125
AYR	25,868	24,536	41,867	42,299	22,645	23,659	161,881	162,630
BANFF	11,405	11,345	59,102	59,019	629	653	15,475	15,213
BERWICK ...	13,735	13,294	48,803	48,297	3,427	3,339	63,672	64,940
BUTE	2,270	2,207	6,134	5,995	534	448	10,551	10,870
CAITHNESS ...	9,945	9,323	31,884	31,785	1,208	1,095	24,621	25,143
CLACKMANNAN ...	1,159	1,123	1,908	1,711	1,036	1,014	6,517	6,728
DUMFRIES ...	20,448	19,978	45,220	45,623	19,254	19,887	106,172	104,775
DUNBARTON ...	4,687	4,643	4,133	3,960	2,264	2,277	23,104	22,459
EAST LOTHIAN ...	7,759	8,263	16,079	15,759	1,216	1,531	28,724	27,985
FIFE	23,000	24,126	26,143	26,072	3,504	3,770	78,726	77,223
INVERNESS ...	11,731	11,298	20,152	21,049	10,560	10,665	54,235	53,819
KINCARDINE ...	11,771	12,589	34,965	35,248	624	592	13,219	11,336
KINROSS ...	2,748	2,714	5,660	5,647	445	760	13,109	12,627
KIRKCUDBRIGHT ...	10,955	10,635	35,387	37,150	11,889	12,564	89,255	87,216
LANARK	28,588	28,222	29,651	30,912	14,017	13,493	107,624	107,587
MIDLOTHIAN ...	9,856	9,944	15,951	16,956	1,640	3,621	45,186	41,701
MORAY	6,245	6,455	32,963	32,469	279	297	10,819	10,614
NAIRN	1,640	1,675	8,751	8,737	129	95	2,732	2,524
ORKNEY	11,032	11,075	34,271	34,084	1,279	844	17,817	17,657
PEEBLES	2,457	2,306	7,789	6,505	1,704	2,624	28,552	28,996
PERTH	30,707	30,543	55,912	54,129	11,793	12,450	105,146	104,258
RENFREW ...	7,205	7,085	5,392	5,541	6,200	6,167	44,523	44,135
ROSS & CROMARTY	12.665	12,812	35,663	34,102	4,479	5,680	26,411	24,877
ROXBURGH ...	10,684	10,076	49,405	48,392	7,766	8,395	63.480	62,803
SELKIRK	1,426	1,369	6,789	6,027	2,302	2,262	14,687	14,754
STIRLING ...	9,204	9,269	8,734	8,291	8,646	7,997	54,930	57,104
SUTHERLAND ...	4,597	4,460	5,731	5,747	1,688	1,906	9,092	8,843
WEST LOTHIAN	5,777	6,060	3,365	4,014	1,800	1,499	22,439	21,744
WIGTOWN ...	8,846	8,825	46,181	44,927	6,065	6,753	53,361	54,607
ZETLAND ...	1,713	1,689	496	636	2,229	2,559	13,735	12,856
TOTAL ...	396,679	396,423	1,033,375	1,024,031	170,322	178,781	1,446,060	1,436,855

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1936, with COMPARISON for 1935.

COUNTIES	Horses *		Cattle †		Sheep †		Pigs	
	1936	1935	1936	1935	1936	1935	1936	1935
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
†ABERDEEN ...	21,430	21,097	182,181	177,256	386,269	391,574	30,064	35,091
†ANGUS	6,927	6,830	53,127	54,502	200,346	208,350	14,093	14,524
†ARGYLL	3,931	3,926	48,550	50,269	667,141	693,779	4,092	4,912
AYR	7,115	7,049	127,963	128,368	417,044	425,219	14,928	18,678
†BANFF	6,328	6,267	43,966	43,907	116,810	116,981	6,584	8,133
BERWICK ...	3,253	3,327	28,772	28,387	390,828	388,347	7,116	8,054
BUTE	940	932	9,514	9,694	44,193	46,007	581	726
†CAITHNESS ...	4,256	4,183	20,991	21,492	220,322	216,695	1,734	2,021
CLACKMANNAN ...	419	438	4,514	4,317	14,978	14,163	963	964
DUMFRIES ...	5,364	5,364	82,461	83,582	597,097	608,801	12,468	14,004
†DUNBARTON ...	1,220	1,212	14,759	14,743	73,482	74,439	3,456	3,20
EAST LOTHIAN ...	2,571	2,584	16,755	17,305	150,955	157,056	6,091	5,84
FIFE	6,828	6,733	52,449	52,931	146,417	152,904	12,969	14,7
†INVERNESS ...	5,336	5,438	42,750	43,772	460,744	465,206	3,483	3,5
†KINCARDINE ...	3,479	3,523	29,326	29,182	70,937	74,092	4,851	5,4
KINROSS ...	786	785	6,888	6,777	37,370	37,742	1,105	1,4[illegible]0
†KIRKCUDBRIGHT ...	3,615	3,499	64,509	65,198	389,816	406,279	13,759	14,9[illegible]1
LANARK	5,897	5,803	82,098	80,554	245,399	255,624	10,762	11,47
MIDLOTHIAN ...	2,443	2,445	19,753	20,060	191,075	196,154	18,821	18,84
MORAY	3,517	3,454	24,173	24,095	44,289	49,710	6,153	6,13
NAIRN	982	987	6,613	6,778	12,467	15,463	1,099	1,09
ORKNEY	5,627	5,608	39,261	39,467	74,813	74,396	2,335	2,87
PEEBLES	674	632	7,623	7,739	198,553	202,116	911	87
†PERTH	8,778	8,718	73,095	74,175	614,286	641,228	11,573	13,39
RENFREW ...	1,897	1,884	27,950	27,925	45,464	47,162	7,950	7,773
†ROSS & CROMARTY	4,796	4,771	35,133	36,279	313,569	330,476	5,966	6,36
ROXBURGH ...	2,872	2,850	28,964	28,062	575,762	581,111	3,819	4,601
SELKIRK	468	461	4,440	4,273	187,964	193,093	620	660
STIRLING ...	3,174	3 106	38,424	37,958	126,851	126,393	5,813	5,338
†SUTHERLAND ...	1,487	1,502	7,781	8,146	207,224	211,328	472	663
WEST LOTHIAN	1,493	1,502	14,663	14,763	21,271	24,931	4,385	4,12
WIGTOWN ...	4,026	4,041	63,546	65,680	145,452	155,051	17,274	19,51
ZETLAND ...	1,649	1,714	10,056	10,858	168,209	184,545	94	18
TOTAL ...	133,578	132,665	1,313,048	1,318,494	7,557,397	7,766,415	236,384	260,2

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total for these in Scotland is given in the summary table on p. 117.

† Including Cattle and Sheep grazed on Deer Forests.

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SOME RESULTS OF TRAPPING THE SHEEP BLOWFLY

(*Lucilia sericata* Meigen)

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As a part of the investigation of the Sheep Blowfly initiated in 1933 by Professor J. Ritchie at Aberdeen, it was decided to study the problems connected with trapping flies. The idea was to set up traps on a sheep farm on arable land to discover:—(1) In what situations blowflies were most numerous. (2) The numbers of different species of flies caught, their species and sex, so as to determine the numbers of blowflies relative to the total catch of flies. (3) The relationship of the numbers of flies to weather conditions, such as temperature, sunlight, wind, rain. (4) The relation between the numbers of flies and the numbers of sheep struck. (5) The merits and disadvantages of traps and lures as a practical means of reducing the fly pest.

Before these problems are discussed some details may be given about the blowfly itself and the methods of conducting the experiments. From the observations of my colleagues (Ritchie, 1934 and Ratcliffe, 1935) and myself in Aberdeen, and from the work of Macdougall (1909) for the whole of Scotland, and of Maldwyn Davies (1934) in Wales, it has been found that only one species of fly seriously strikes sheep in Great Britain. This is the Sheep Blowfly, Sheep Maggot Fly or Greenbottle Fly, known as *Lucilia sericata* Meigen. For convenience I shall call it in this paper the Blowfly. That this fly was the culprit was proved by collecting maggots from sheep from different parts of the country from the earliest to the latest strike and culturing them till they became flies. Other species of flies have occasionally been reared from maggots taken from the fleece of sheep, but these species occur so seldom that they are of little importance, and they may be secondary invaders after the sheep has been struck by the blowfly or has been injured externally.

Since it was necessary to collect all the flies in each trap at frequent intervals, the traps were made simple and small. Designed by Professor Ritchie and Mr Ratcliffe, they were made of glass and metal with wire gauze or perforated zinc. For uniformity in the experiments all were of the same pattern, supplied with equal quantities of bait, and their respective catches were collected within an hour on the same day. When it was desired to collect the flies from the traps the catch of living insects was stupefied by the fumes from a few drops of chloroform and the flies were transferred to paper bags which were labelled with the number of the trap, the date and other appropriate notes. The flies were stored till it was convenient to examine them in detail. After the catch was removed the trap was reset. The traps were baited with liver which was kept partly immersed in 25% solution of sodium sulphide in water. The reason for using sodium sulphide solution was that the work of Freney (1932) and others in Australia showed that this solution kept the bait from becoming too dry and also increased its attractiveness for the flies. This conclusion received some support from one of the experiments at Aberdeen.

In what situations are Sheep Blowflies most numerous?—This problem was tested in the sites chosen for twelve traps during 1933-34. During 1933 seven traps were erected in different sites on the sheep farms of the Rowett Research Institute at Aberdeen at a height of 400-600 feet above sea-level and between 5½ and 6½ miles inland. The seven traps were scattered amongst the farms, and the minimum distance in a straight line between any two traps (No. 3 and 10) was 55 yards, and the maximum distance in a straight line between any two traps (No. 2 and 5) was 1970 yards. Traps were erected on 9th May 1933 and dismantled 20th October 1933 after each had been in use for 165 days. A similar trap was erected in the author's garden, which lay on the edge of the town amongst pasture fields grazed by sheep. This trap was in use for only 60 days between 17th July and 10th October 1933. It lay about 3 miles from the nearest trap on the Rowett farms, about 300 feet above sea-level and 3 miles from the sea. During 1934 three traps on the sheep farms were in action for 51 days between 7th June and 27th July 1934, and two traps were used for 39 days (19th June to 27th July 1934) to test sodium sulphide solution against ordinary water added to the bait. The five traps were scattered amongst the farms, and the minimum distance between any two traps (No. 16 and 17) was 33 yards, and the maximum distance in a straight line between any two traps (No. 13 and 17) was 660 yards. All the traps except 16 and 17 lay in sheep pastures or separated from pastures by very few yards. Traps 16 and 17 lay between a turnip and a hay field and about 100 yards from pasture. The soil was generally a medium loam but peaty on the hillside, where the pasture varied from rich clover leys to sparse grass. From the analysis of the catches of these twelve traps the conclusions following were drawn. Other larger traps were experimented with, but their catches were not analysed in detail.

NUMBERS OF SHEEP BLOWFLIES AND OTHER FLIES TRAPPED AT ABERDEEN DURING 1933-34

Date	Period of Trapping in Days	Number of Trap	Site of Trap	Sheep Blowfly *L. sericata*	Greenbottle Flies *L. caesar* and *L. illustris*	Other Flies	Total Catch of Flies
9/5/33—20/10/33	165	1	Hillside	625	2,622	about 12,000	15,247
,,	,,	2	Rabbit warren	114	1,812	,, 5,000	9,626
,,	,,	3	Pasture	193	2,837	,, 7,000	10,030
,,	,,	4	,,	345	1,990	,, 12,000	14,335
,,	,,	5	,,	830	6,809	,, 10,000	17,639
,,	,,	8	Piggery	455	8,749	,, 9,000	18,204
,,	,,	10	Wood	5	1,363	,, 5,000	6,368
				2,567	26,182	60,000	88,749
17/7/33—10/10/33	60	×	Garden	958	12,661	13,604	27,223
7/6/34—27/7/34	51	13	Hillside	361	908	4,694	5,963
,,	,,	14	Pasture	406	1,069	6,587	8,059
,,	,,	15	,,	1,129	4,212	6,744	12,085
19/6/34—27/7/34	39	16	Turnip field	328	1,053	3,857	5,238
,,	,,	17	,,	290	1,278	2,930	4,498
				2,514	8,520	24,812	36,843
Totals for Whole Period of Trapping ...				6,039	47,363	94,416	152,815

During 1933, trap No. 1 lay on the edge of a moor on a hillside; No. 2 in a rabbit warren beside a narrow stream adjoining a marsh and dense pine woods; No. 3 and 4 by a stone wall between pasture fields; No. 5 by a wire fence between pastures; No. 8 in a piggery between sheep pastures; No. 10 under a dense beech wood fringing the field in which lay No. 3; the trap in the author's garden was separated by a wire fence from sheep pasture. During 1934 trap 13 was on the hillside amongst grass and gorse; No. 14 between pasture fields; No. 15 within a few yards of the site of 5 in 1933.

The Table enumerates the total catch of flies of each trap and shows considerable differences between the sites. The catch of each year should be considered separately; one reason being that the catch of the early part of 1934 was much larger than that of the corresponding period of 1933. This may possibly be explained as the natural increase after the abnormal numbers of blowflies present during 1933. The traps were all alike and were subjected equally to the weather each year, therefore some other cause must account for the difference in the numbers of their catches. The explanation is that the blowfly has a well-developed preference for a combination of moist carrion, warmth, sunlight and shelter from wind. The moist carrion was provided by the bait in the traps, but the other factors in the combination were influenced greatly by the site of the traps. During 1933 the site of trap 5 fulfilled these conditions very well and, being at the corner of a field where numbers of sheep and cattle congregated during the day, it probably was surrounded by a larger number of blowflies than the sites of the other traps. Site 1 was good, but on higher ground and more exposed to strong winds. It was surrounded constantly by sheep. Site 8 was good, but its immediate neighbourhood offered no satisfactory breeding-ground for blowflies. Site 2 by a rabbit warren was poor. In spite of its seemingly excellent position it did not fulfil all the conditions. It was too shaded from the sun and warmth, also sheep did not favour its particular corner of the field. Sites 3 and 4 were very similar, but 4 was exposed to the sun all day and 3 was shaded for part of the day. Neither sheep nor cattle frequented them particularly. Site 10 was only 55 yards from 3, but the dense beech wood so reduced the light, and consequently the temperature, that only 5 blowflies were caught in the trap during the year. It will be noticed that the trap in my garden caught more flies than any of the traps on the farms, and it functioned for only 60 days compared with 165 days of those on the farms. It was the same type of trap as the others and was baited like them. Its site fulfilled all the necessary conditions.

During 1934 the catch was greatest from trap 15, which was practically in the same position as trap 5 of 1933. Trap 14 lay near the site of 4 and 13 was on a hillside rather like the site of 1 but not so frequented by sheep. Considering the time that traps 16 and 17 were in use they were about as effective as traps 13 and 14. Their sites were good and they were only about 110 yards from trap 15, and if they had been nearer to sheep pasture it seems likely that their catch would have been larger.

The site of the trap is of great importance in determining the catch of blowflies. The most suitable places for catching large numbers of blowflies are those exposed to the sun all day, but sheltered from strong wind and close to where numbers of sheep or cattle gather during sunshine. A wall or hedge at the side of a field, an embankment, or a cutting may afford an excellent wind-break for the trap, which lies in the sun all day and is protected by some simple device from being upset by domestic animals, particularly dogs which seek the bait.

Number and Species of Flies caught.—The site of the trap influences directly the numbers of blowflies caught. Despite the fact that the trap rests in a good site, the numbers caught rise and fall frequently during the year. The fluctuations in numbers may be explained thus: Theoretically the flies in the fields increase steadily in numbers from the time they first appear till they reach their maximum in early August, and after that time the numbers decrease steadily till the flies disappear in October. But under natural conditions the flies are subject to many different factors that make the numbers rise and fall suddenly both before and after the period of maximum abundance. The catch of the trap rises and falls more or less in accordance with the field population, but it is strongly affected by factors like wind or cold that have little immediate effect in reducing the field population in summer. Also a factor like the introduction of a flock of sheep would probably increase the numbers of flies in a field.

Actually the first blowfly was caught on 7th June 1933, the maximum number during the first week of August, and the last individual on 3rd Oct. 1933; in 1934 the first was caught 10th June. Undoubtedly the flies may be on the wing and may strike sheep both earlier and later than these dates, but this occurrence would be governed by weather and locality. Also the flies caught on the earliest dates would have emerged from puparia in the soil at least a day previously to their capture. A male was caught with the females on 7th June and the last male on 29th September, 1933, so that males may be trapped during the same period as females, but out of the total catch of 6039 blowflies only 554 were males, or a proportion of nearly 10 females to 1 male. Now breeding experiments show that males occur as commonly as females, therefore the larger number of captured females suggests that the bait is more attractive to them. This is possible for two reasons: firstly, the female is probably attracted to the bait to lay eggs, and secondly, she may need a meal of protein. She must have a meal of protein before she can lay fertile eggs, according to Salt (1932) and Mackerras (1933), whilst the male does not require a meal of protein before he can fertilise a female, and he has not the duty of finding a nursery for his progeny.

In the Table readers will observe that the proportion of blowfly (*sericata*) to the total catch of flies is small. The percentage varies from 1/12% for trap 10 for the whole season, to $9\frac{1}{3}$% for trap 15 for part of another season. The catch of blowflies averaged about 3% of the total catch of flies in the seven traps on the Rowett Farms during the whole season of 1933.

Besides the blowfly about 40 other species of flies were caught and they merit brief consideration, though all are harmless to sheep except two species of Bluebottles and they are practically harmless. Since each species of fly has its preferences for certain types of country, the site of the trap influenced directly both the numbers of blowfly and of the other species caught. Traps on the hill caught large numbers of Flesh Flies. The commonest of the Flesh Flies is *Cynomyia mortuorum* L. which may be the size of a bumble bee; its face is orange-coloured and its abdomen shining blue. The other Flesh Fly is *Sarcophaga carnaria* L. which is almost as large as *Cynomyia* and its body is checked black and white. I have seen these flies caught abundantly in traps on hills in different parts of North-East Scotland. Traps near streams, even a shallow ditch, caught large numbers of flies of different species that frequent wet soil and are predacious, feeding as adults on other flies and as maggots on the grubs of other insects, chiefly flies. No benefit seems to arise from catching these predacious flies or others to be mentioned later.

Besides a preference for a particular type of country some species of flies like more shade and others greater cold than the blowfly. The proportion of greenbottles (***Lucilia caesar*** and ***illustris***) in trap 10 (see Table) shows that they tolerated more shade and cold than the blowfly. Also this trap caught large numbers of the two species of bluebottles, each of which will frequent darker and colder places than the blowfly. Besides the Flesh Flies and the flies frequenting wet places, which were more or less confined to certain sites, there were numbers of different species of flies common to all the traps but more abundant at some than at others. As would be expected, the largest number of species caught breed on carrion, as do the greenbottles and bluebottles. Next in abundance came the fly *Hydrotaea dentipes* F., a small dark fly usually mistaken for a Housefly. It imbibes the juice of carrion, and it lays its eggs on carrion so that its larvae may devour the maggots of other flies already present there. Species of dung-flies, *Scatophaga*, also appeared in the traps in small numbers. They are actively predacious on other flies. The predacious flies do not attack or annoy man or domestic animals, and since they reduce the numbers of injurious insects their capture may be regarded as a disadvantage of trapping. Other species caught include those that breed in rotting organic matter and some that frequently visit cattle or sheep dung. These were probably attracted by some of the odours of the bait and possibly by seeing crowds of other flies in and about the trap. No Houseflies and no blood-sucking flies like Clegs or *Stomoxys* were caught.

The blowfly is a Greenbottle Fly, and owing to its importance the other species of captured Greenbottle Flies deserve special consideration. At least four species of flies caught may be called Greenbottle Flies. Characterised by their metallic green, blue, or golden colour, and by their similarity in structure and size they resemble one another so closely that without a considerable knowledge of their anatomy it is impossible to distinguish the blowfly from the rest. One of them breeds in dung, the fly *Euphoria cornicina* F. It seldom enters traps, only three having been caught during during the whole period of trapping, but it appears in the field early in May and it is to be found till late in October, and from June to the end of September it assembles in numbers on fresh dung of cattle and sheep and on flowers like ragwort and Michaelmas daisy. Because of its habits it is the most frequently-seen greenbottle, and it is harmless to sheep. The other three species breed in carrion and belong to the genus *Lucilia*. One is *L. sericata* (Meigen), the Sheep Blowfly, which has been discussed already, another is *L. caesar* (L.), and the third is *L. illustris* (Meigen). Both *caesar* and *illustris* are harmless to sheep. Even an expert finds it difficult to separate *illustris* from *caesar*, and then it can only be done with certainty in the males (Aubertin, 1933).

It will be noticed in the Table that the proportion of greenbottles (including *sericata*) to the whole catch is high. It varied from 16 to 50%, and its volume was considerable in all the traps. A flockmaster knowing that a greenbottle was the cause of strike and seeing the massed hundreds or thousands of greenbottles in a trap, would get a mistaken idea of the efficacy of trapping unless he could separate the blowfly from the rest: As mentioned above, the blowfly averaged about 3% of the total catch of a trap during 1933. The proportion of *sericata* to *caesar* and *illustris* is shown in the table.

Some species of flies attain their maximum abundance during the year a little earlier or a little later than the blowfly. The results are that besides the daily fluctuations in the catch due chiefly to weather there is a rise and fall in the numbers of each species caught, as happens with the blowfly.

During the entire period of trapping the proportion of females to males of the blowfly was 5485 : 554, other greenbottles 43,877 : 3486, other flies 83,906 : 14,510. These figures show that females were much more numerous than males in the traps. Only in one species, *Cynomyia mortuorum*, out of the forty species caught were the males more abundant than females.

The bait attracted to the traps various species of beetles that feed and breed in carrion. Conspicuous amongst the beetles was the Burying Beetle, *Necrophorus investigator* Zett., a sturdy insect measuring from ¾ to 1 inch in length and marked with two orange-coloured bands across its black body. The insect is common throughout the country, but from its habit of living under carrion it generally escapes notice. The insect is often mistaken for the Colorado Potato Beetle, which is easily distinguished by its smaller size and the yellow lines running along and not across the body. Another larger and stouter beetle visiting the bait was the Sexton Beetle, *Necrophorus humator* F., which is entirely black and so not as conspicuous as the Burying Beetle. Both these insects fly and they were common at all the traps, and I have seen them caught by the dozen in fly traps set by farmers.

Correlation of Catch of Blowfly to Weather.—The blowfly at all stages of its life is greatly influenced by weather. The egg, larva, pupa and adult have each very narrow limits of temperature and humidity between which they flourish. The temperature and humidity of the atmosphere and soil determine the numbers of generations of flies in the year (Wardle, 1930). It is known from the work of Davies (1929) that the flies pass the winter as maggots in the soil and that in spring, as the soil temperature increases, the maggots creep up and pupate just below the surface. The weather again determines when the flies will emerge from the puparia. A succession of hot days towards the end of May or early in June induces the flies to emerge from the puparia in the soil, and 5 to 8 days later (Cousin, 1929, Salt, 1932, Brumpt, 1933) the fertilised females after a meal of protein will be capable of laying fertile eggs on sheep.

The variation in catch of flies was correlated with meterological data recorded daily by Mr R. Bain, B.Sc.(Agr.), at Craibstone Farm, which lies between ¾ and 1½ mile distant from the sites of the traps. Unfortunately, the relative humidity was not recorded. To Mr Bain are due my thanks for his help.

Flockmasters know that strike is much commoner some years than others, and they know that it is associated with warm or hot weather with the absence of strong wind, and that it is often severe during muggy weather or after showers of rain. Correlating the catch of flies to the weather showed that the number of flies was nil on continuously wet or cold dull days; few were caught when spells of warm sunshine came between longer periods of showers, but many were caught when one or two showers fell during a bright warm day; few were caught during strong winds; a fair catch appeared during muggy warm days, and the largest catches occurred when the weather was hot or warm with some hours of sunshine and no strong wind. From these statements it will be seen that the numbers of flies caught in traps varies quite well with in accordance with the popular idea of the way strike is affected by weather. As a matter of fact the variation in numbers of sheep struck during the period of trapping on the farms corresponds quite well with the variation in numbers of trapped flies.

The meterological conditions chiefly affecting the blowfly are temperature, light, rain and wind. The relative humidity of the atmosphere is known from the work of many authors, including Davies and Hobson (1935), to be of great importance in determining the activity of the fly; it always acts in combination with the other factors of the climate, but as it was not measured during the period of experiment it will be neglected in this paper. From these experiments it is not possible to sift out accurately the relative effects of temperature and sunlight on the blowfly. The temperature during the period of 1933 varied from 81° to 37° F., and large numbers of flies were caught when the temperature during the day varied from 80° to 62° F. or from 64° to 46° F. Rain stopped the catch as would be expected. Strong wind, even when it was not associated with clouds and low temperature, reduced the catch greatly.

Correlation of Catch of Blowflies to Numbers of Sheep Struck.—Unfortunately the correlation between the numbers of sheep struck in the vicinity of each trap and the numbers of blowflies caught in the trap cannot be worked out accurately. The movements of the sheep made uncertain the trap they were nearest when struck. Nevertheless, during 1933 flies struck 86 ewes and 277 lambs out of a total of about 3000 sheep, and most of the sheep were grazing amongst the traps when struck. The rise and fall of the numbers of flies caught corresponds fairly closely with the rise and fall in the numbers of strike.

Traps and Lures.—The flockmaster will want to know if trapping is a practical proposition to reduce strike in Scotland. Our experiments were not designed to test that question. They do not show if trapping reduces the percentage of strike, but they show that the numbers of blowfly constitute only a small percentage of the catch. To test if trapping would control strike necessitates experiment on a large scale for one year or more.

It seems doubtful if trapping will reduce strike effectively even if large numbers of flies are caught. It should be pointed out that we do not know the numbers of blowflies present over the countryside at any time, nor the migration over any fairly large area of country, nor the radius controlled by a trap, nor the distance flies will travel. Gurney and Woodhill (1926) showed that flies bred from a single carcase in New South Wales could travel as far as 10 miles from the place where they were bred, thus covering an area of over 300 square miles. Conditions in Scotland vary, and they are not the same as those in New South Wales, nevertheless this work gives an idea of the way the blowfly can spread.

The trap catches merely a small percentage of blowfly, and it destroys large numbers of flies the larvae of which compete with and oust blowfly larvae in nature. Holdaway (1930) has described how an initial population of 50,000 blowflies was eventually reduced to 231 flies by competing larvae in the south of France. Fuller (1934) has shown how the various species of insects control the numbers of one another when breeding in carrion in Australia.

The bait loses its attraction quickly and the trap requires to be cleaned out and rebaited fairly often; when a large number of traps are in operation this means much time and labour. The cost of the traps themselves may amount to quite a large sum if many traps are used.

Trapping for the control of strike is not practised on an extensive scale in Great Britain and there are no records of its having been tested here. It is practised and advocated by authorities in some regions of South Africa and Australia, where the problem of strike is complicated by the size of the country and of the flocks, and by the fact that *L. sericata,* besides being only one amongst five species of flies concerned in primary strike, is active all the year round.

Davidson (1933) trapping in the Adelaide district of S. Australia caught 1315 *sericata* out of 29,651 flies in one trap and 58 *sericata* out of 7,343 flies in another trap, so that the percentage of *sericata* caught by him was not large. Newman (1924) describes how to make cheap and effective blowfly traps out of kerosene tins and wire gauze for use in Western Australia. He and Clark (1926) describe a trap made of tin, wood and wire gauze, claimed to be more effective than a modified South African trap since the respective catches were 118,000 and 82,000 flies, which belonged to nine different species, and were caught between 15th April to 14th May. He, O'Connor and Andrewartha (1930) give details of the catches of flies at each station in W. Australia, and they say that *sericata* never constituted less than 15% of the total of the different species of blowflies captured. Freney (1932) has experimented in Australia on artificial baits for blowflies, and this work would have an important result if a cheap bait could be found which was more attractive to *sericata* than to the other species of flies. Wahl and Du Plessis (1923) describe two types of traps made of tin for use in S. Africa. They found that 23% of the total catch for season was sheep maggot flies, but there are five species of flies in S. Africa that cause primary strike. Smit (1926) described a modification of the Wahl and Du Plessis Trap and from a comparison of it with four existing types of traps he found it superior. During one year it caught 310,164 flies. Parman, Laake, Bishopp and Roark (1928) tested blowfly baits and repellents in the U.S.A. Laake and Cushing (1930) have studied fly trapping on the ranges of Texas. They were concerned with the flies attacking cattle, not sheep, but their work is mentioned here since they consider that fly trapping reduced the fly population by 36·2% in one area in comparison with a similar untrapped area. They used 313 traps on approximately 200 sq. miles of ranch land.

In Scotland there are various types of Blowfly traps on the market, and others have been designed but not marketed by certain farmers. I do not propose to discuss any type of trap in detail in this paper, but some comments on traps may help readers. The principle of the trap depends on the reactions of the blowfly to food and light. The trap contains a bait which attracts flies to feed and in the case of females to lay eggs. Having entered the trap through an opening in the wall, the fly when it wishes to leave is attracted to the brightest light and the trap is so built that the brightest light leads to the prison chamber and is much stronger than the light coming from the entrance(s) of the trap. In all traps used in the field and known to me the fly could escape easily if it had the sense to return the way it entered.

The ideal trap to be sought in practice should fulfil the following conditions: (1) size sufficient to accommodate many thousands of flies without the dead insects blocking the entrance(s) of the prison chamber; (2) cheapness, but the number of years of service modifies this condition; (3) a method of keeping the bait moist and some means of protecting it from flies which will otherwise breed on it; (4) the catch of flies and the bait should be separate, so that one can be easily cleaned out without disturbing the other. The sizes may vary considerably, but between 2 and 4 cu. ft. capacity is probably the most convenient. These sizes correspond with those used in S. Africa and Australia. The traps may be built of wood or metal with wire gauze, perforated zinc, or glass to allow the entrance of light. They may be rectangular or cylindrical. Tins or drums for containing chemicals like oil, soap, carbide, petrol, have been made into successful traps and they have the advantage of cheapness, but it is essential that they should be cleaned thoroughly before use, for the odours of some of these chemicals might mask the smell of the bait or even repel flies. The bait should lie in a receptacle containing water and the receptacle should have an outlet for surplus water so that the bait does not become completely submerged or float about if rain falls on it. The bait in the receptacle should be protected by wire gauze or perforated zinc which will allow the odours to escape but will prevent flies breeding on the bait. Too often this factor is neglected in traps which consequently serve as a breeding place for flies. This factor may be overcome by adding to the water of the bait 0·2% nicotine sulphate solution, which will kill maggots without reducing the attraction of the bait.

Most of the flies soon die in the trap, and if the numbers accumulate and get soaked with rain they form a rotting mass on which the new captives, particularly bluebottles, will lay their eggs. If the mass remains moist for a few days, maggots emerge from the eggs, feed on the dead flies and then may escape from the trap to become adult flies. To prevent this happening the catch should be kept dry or removed from the trap before it becomes massed together. The smoke from burning litter or the fumes of a small quantity of petrol will kill the flies in the trap when the chamber containing them is cleaned.

Another type of trap or lure has been employed commonly by farmers. It consists of carrion, usually a dead rabbit, hung over stream. The idea of using the lure is that the blowfly will strike the rabbit in preference to sheep, and that the maggots will drop from the carcase into the stream, where they will be drowned or serve as food for fish. It is possible that if the lure is hung in a sunny place one or more sheep blowflies may strike it, but this seems unlikely to reduce the chance of sheep being struck. If competition with the larvae of other species of flies does not exterminate the larvae of the blowfly before they have eaten enough to become flies, there is a chance that a few may fall into the stream. If they escape fish and other enemies there is little chance of their being drowned. Brannon (1934) found that larvae survive immersion for long periods in different liquids. Many larvae which fell into a stream would have a fair chance of surviving and becoming flies. Sometimes the lure is suspended over a pail of sheep dip into which the maggots fall. This idea is practised on a larger scale in S. Africa, where the carcase of a beast like a sheep that has died on the farm is placed on wire netting suspended over the mouth of a tank containing arsenite of soda dip.

To test the value of the dead rabbit lure three young rabbits were placed on suitable sites for strike on Craibstone Experimental Farm, Aberdeen, on 17th June 1936. They were so arranged that the maggots reared on them could be caught in receptacles containing moist soil. The first rabbit was suspended from a hawthorn bush, the second lay on soil, the third on soil in a trap which caught the flies; it was exposed to the flies and was the bait of the trap. A fourth rabbit was used as the bait of a trap, but it was protected from the flies. The weather remained hot and dry. At the end of 7 days rabbit 1 consisted merely of dry skin and a few bones, and 2 days previously this had happened to rabbit 2. The maggots had eaten every particle of soft tissue on the two carcases. .Traps 3 and 4, containing rabbits, by the end of 7 days caught large numbers of flies, but rabbit 3 was not so greatly infested with maggots as rabbits 1 and 2 had been. Competition for food was very severe on rabbits 1 and 2, each of which was overpopulated with maggots, resulting in the population being undernourished and puny. The starving, undersized maggots quested in a heaving mass for food under the skin of each rabbit, and in the case of rabbit 1 individuals kept dropping out of the mass and landing on the soil of the receptacle placed beneath the beast, and in the case of rabbit 2 they just crept away where the soil was dampest. Finally many pupated and emerged as flies in July and August, but the majority died as maggots. The flies that emerged from rabbits 1 and 2 were about 700 undersized Greenbottles (*L. caesar* and *L. illustris*) and a few puny Bluebottles (*Calliphora erythrocephala*). Rabbit 3 reared many Bluebottles (*C. erythrocephala*) which were large or normal in size since competition for food did not exist at the start and it was not severe later, but another factor, drought, intervened with rabbits 3 and 4. Rabbit 3 reared some hundreds of bluebottles, but by the end of a month it was too desiccated to rear more maggots or to serve as bait. Rabbit 4 never reared maggots, and at the end of the month it was too desiccated to attract flies. *Not a single sheep blowfly was reared from the* *three rabbits.* It is possible that Blowflies laid eggs on the rabbits, but that the competition amongst the different species of maggots exterminated those of the blowfly.

In conclusion, I have to express my thanks to Professor Ritchie for inviting me to help in the Blowfly Investigation with my colleague Mr F. N. Ratcliffe under the auspices of the Agricultural Research Council, to Professor Hendrick and the Governors of the North of Scotland College of Agriculture for permitting and encouraging me to undertake work not solely connected with the College, and to the Staff of the Rowett Research Institute, whose aid was essential for the investigation.

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SOME RECENT WORK ON THE PRESERVATION OF PERISHABLE FOODSTUFFS

With Special Reference to Drikold Refrigerated Transport

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Less than forty years ago in his Presidential Address to the British Association, Sir William Crookes issued the following warning:⁽¹⁾ "England and all civilised nations stand in deadly peril of not having enough to eat—as mouths multiply, food resources dwindle." This statement was based upon considerations of world supplies and estimated future world demands of wheat. It is interesting, however, to note the following prophecy at the conclusion of his address:⁽²⁾ "And in the next generation instead of trusting mainly to foodstuffs which flourish in temperate climates, we probably shall trust more and more to the exuberant foodstuffs of the tropics, where, instead of one yearly sober harvest, jeopardized by any shrinkage of the scanty days of summer weather or of the few steady inches of rainfall, Nature annually supplies heat and water enough to ripen two or three successive crops of foodstuffs in extraordinary abundance."

Nowadays, owing to the combined labours of the biologist, the chemist, and the refrigerating engineer, overseas supplies of perishable foodstuffs can be placed on the British market to fill in the gaps when our own products are out of season and, in some cases indeed, the Empire or foreign products are imported during our own season, and even compete with them. Thus we now have nearly all the "fruits of the earth" made available to us so that no longer is an actual famine to be feared, although what may be called an economic famine sometimes does occur.

Foremost amongst the British scientists was Sir William Hardy, F.R.S., the first director of the Food Investigation Board, who devoted the last seventeen years of his life to the study of foodstuffs and the investigation of the best methods of their storage and transport.⁽³⁾ Under his leadership the Low Temperature Research Station at Cambridge came into being, the Ditton Laboratory, Kent, for the study of fruit problems, and Torry Research Station, Aberdeen, for the study of the problems of the distribution and storage of fish. It is, therefore, only fitting that in a paper on this subject mention should be made of one or two of the more important results obtained under his leadership.

One of the first investigations at the Low Temperature Research Station at Cambridge was into the biological and chemical changes occurring in dead meat. Investigation showed that there are two important changes:

(*a*) *Autolysis*—*i.e.*, the changes brought about by the action of enzymes.

(*b*) *Growth of Micro-organisms—i.e.*, growth of colonies of bacteria and moulds.

(*a*) *Autolysis.*—Autolysis can be checked by a reduction of the temperature, indeed, at 32°F. (0°C) autolytic action is so slow that it is negligible during storage up to six months. It would be quite easy by carrying the temperature still lower down to 14°F. (−10°C) to stop this autolytic action altogether, but beef, unlike mutton and lamb, cannot be frozen satisfactorily without deterioration in quality; further, it is obviously cheaper to maintain a temperature of 30°F. (−1°C) than a temperature of 14°F. (−10°C).

(*b*) *Growth of Micro-organisms.*—The period which elapses before bacterial action becomes pronounced depends, of course, on the original degree of contamination, and this in turn depends upon the cleanliness of the slaughterhouses and the care which is taken in handling and dressing the meat during its preparation, transport and storage. The storage life of the meat may be more than doubled by careful attention to these points so that, under conditions of the most scrupulous cleanliness, meat is still edible 17 or 18 days after killing. It has been found, however, that the presence of carbon dioxide (CO_2) kills some meat bacteria and decreases very considerably the rate at which others grow.(4,5,6) Too high a concentration of carbon dioxide tends to discolour beef,(7,8) but in the case of bacon and pork it has been found that an atmosphere of 100% CO_2 extends the storage life very considerably without any undesirable effects taking place. This work finds its practical application in the transport of chilled beef from Australia and New Zealand at a temperature of 30°F. (−1°C) in an atmosphere containing 10% CO_2, the first shipment having been made from New Zealand in the " Port Fairy " in 1933. Since then a large number of vessels have been fitted out for gas storage of beef and are in regular service from Australia and New Zealand, a voyage of six weeks' duration.

At the Ditton Laboratory, Kent, one of the first pieces of research to be undertaken was a study of the life history of the apple, with a view to discovering a method of prolonging the storage life. Right up to the time that an apple is used, it is still alive and breathing, taking in oxygen and giving out carbon dioxide, and the rate at which this breathing takes place varies in a characteristic manner for any given variety throughout its life. Lowering the temperature decreases the rate of respiration of the apple; for example, an apple at 70°F. (21°C) breathes five times as fast as the same apple at 35°F. (1·7°C). (See Table I, p. 14.) Unfortunately, however, if too low a temperature is maintained (for certain varieties 34°F. (1°C) is too low), then, whilst the storage is satisfactory, the apple begins to break down immediately it is removed to normal temperatures, and so considerable wastage occurs during marketing.(9) It has been found, however, that by arranging the atmosphere of the store chamber so that there is 10% of carbon dioxide and 10% of oxygen present, Bramley Seedlings can be stored for eight months at a temperature of 41°F. (5°C) without damage and can be marketed in the usual manner in good condition.(10) Unfortunately, each variety of apple needs separate study and storage treatment, but this work is still going on and the British grower is now able to store many varieties of apples and pears and release them for sale in small quantities to suit the markets, thus obtaining a better price for the fruit.

One of the early problems tackled by the Torry Research Station at Aberdeen, after its formation in 1929, was to define the correct conditions of running a smoking kiln for the production of kippers, Finnan haddocks, etc., and to devise a kiln in which these conditions would obtain, no matter what were the prevailing atmospheric conditions. In the fish trade up to this time there had been no method of controlling the variables, such as humidity, temperature, rate of drying, etc., except by the skill of the smoker. This work has resulted in the development of an apparatus which can be erected quite cheaply and which ensures a standard smoke being given under all possible atmospheric conditions.(11)

Another question which attracted Sir William Hardy's attention was that of trying to improve the condition of the fish caught and brought to market by our fishing fleets. Whilst commercial stowage in water ice was satisfactory for keeping the catch in good condition where the North Sea fishing grounds were concerned, the fish being only three or four days old on landing, this could not be said with truth of the first portion of the catch of a deep-sea trawler, going as far afield as the Faroe Islands, Iceland or even Bear Island. By a study of the methods in use on board trawlers during the process of handling, gutting and stowing the fish, recommendations were made which extended the period during which fish could be considered fresh from 6 or 7 days (normal commercial stowage in ice previous to this date) up to 11 or 12 days.(12) When it is realised, however, that in the course of a 24-day voyage—which is by no means uncommon—fourteen days are spent in steaming to and from the fishing ground, it can be seen that about a third of the catch will probably be older than 12 days on landing and a portion of it will be 17 days old, so that even with preservation in water ice under the best conditions, part of the catch can no longer be classed as fresh.

A considerable amount of attention was, therefore, paid to this problem at Torry and, as a result, it was decided that freezing the earlier portion of the catch was most likely to offer a satisfactory solution. This was by no means plain sailing, however, as the freezing of fish could not at this time be regarded as completely satisfactory; nevertheless, after a considerable amount of chemical and bacteriological research, a satisfactory process has been worked out and can now be applied, not only to white fish (cod, hake, haddock, halibut, sole, etc.) but to herring also. This last permits of the herring being caught when they are in prime condition, and frozen and stored for a period up to six months. They can then be thawed out and smoked to give a good-quality kipper.(13) This enables us to obtain a British kipper throughout the year, whereas previously during the off-season, when no herring fishing was proceeding round the coasts of the British Isles (March, April and early May), supplies of herring and kippers had to be imported.

In 1931 Drikold, a very pure form of solid carbon dioxide, was placed on the market by Messrs Imperial Chemical Industries Ltd., and it was decided to investigate the possibility of using the carbon dioxide gas as a preservative for wet fish. After a considerable amount of work,(14,15) a large-scale test at Torry(16) and two trials carried out on a trawler by the kind co-operation of Sir John Marsden of Messrs Consolidated Fisheries Ltd., Grimsby, it was decided that whilst a certain amount of success had been obtained, it was not likely that the method would become a commercial proposition. This work, however, indicated various lines upon which Drikold cooling and gas storage would help to preserve foodstuffs during transport.

We have briefly mentioned some of the more important food preservation problems which have been solved by British scientists during the last few years, but it should not be forgotten that most countries now have a more or less adequate staff of trained men devoted to this type of work, so that, as time goes on, we may expect the quality of foodstuff imports not only to be maintained but, if anything, to be improved. It is, therefore, more than ever necessary that home produce of all kinds should be marketed in first-class condition if it is to obtain the maximum price which it deserves. Even amongst home producers, there are some who, because of their proximity to the market, have up till now had a considerable advantage over the more distant producer. However good may be the product, it has often happened in the past that the methods of handling and transport available have not always been all that could be desired, and so perhaps the quality of the product has suffered during its journey to the wholesaler and consumer.

Various remedies have from time to time been devised to overcome this, and recently considerable success has been achieved by means of Drikold transport. Before describing the methods of application to the different commodities, perhaps it would be as well to give a short description of Drikold.

It is a hard white substance somewhat like compressed snow and has a temperature of −110°F. (−79°C). Owing to this low temperature, it is always handled with gloves and never with bare hands. One pound of Drikold is capable of absorbing 275 B.Th.U. (152 cals/gm) as compared with 144 B.Th.U. (80 cals/gm) for water ice. The density of Drikold is about 1·5 as compared with 0·92 for water ice; thus, volume for volume, Drikold has three times the refrigerating capacity of water ice. Drikold has the somewhat remarkable but very useful property that it evaporates directly to carbon dioxide gas under normal conditions, without passing through a liquid stage; it thus has the advantage that no mess is left to clear up after evaporation. Further, carbon dioxide is, as has been seen above, a good antiseptic in the case of many perishables. Whilst Drikold is certainly more expensive than water ice, yet in the realm of transport it has many advantages over either mechanical units or water ice, and so for certain purposes it has definitely superseded either of these.

When considering transport in the British Isles, it must be remembered that perishables are rarely longer than 24 to 36 hours in transit, whether by rail or road, and further that in many cases refrigeration is necessary only during warm or "muggy" weather. Hence the refrigerating equipment, whatever it may be, should not take up loading space otherwise available during normal use, nor should the capital cost of the equipment be great, since it will possibly be used only for a short period every year. With no artificial method of circulation of cooled air available, natural convection is the only method of obtaining the requisite cooling, and since this circulation rate depends upon the difference in temperature between the goods and the refrigerant promoting the circulation, Drikold, owing to its low temperature, will be the best refrigerant to use; it is approximately 23 times as efficient as water ice from this point of view. Considering two other vital factors in connection with transport, namely space occupied and weight carried, Drikold has very decided advantages over water ice; it occupies only one-third the volume, and the weight required is only half that of the quantity of water ice required to give the same refrigerating effect. It is not surprising, therefore, that although the cost of Drikold is admittedly high compared with water ice, it is nevertheless making headway in many applications. The fear has often been expressed that owing to the very low temperature of Drikold, freezing of the foodstuffs must occur during transport. This is a completely mistaken idea, as will be gathered from the description given below of its use with various commodities.

In order to make the best use of any refrigerant, it is essential to use insulated vans or containers, otherwise the cost of cooling, whatever the refrigerant, becomes excessive. The insulation is usually either slab cork, Onazote (a type of expanded rubber) or Alfol, and varies from 1½ ins. to 3 ins. in thickness protected by ⅝-in. to ⅞-in. timber. There are several good types of insulated vans and containers, both rail and road, in use at the present time in this country: the London Midland and Scottish and Great Western Railways have a large number, while the Southern and the London and North-Eastern have a few vans and containers permanently fitted for Drikold refrigeration. The Drikold is placed in a box insulated on all sides but the bottom, which is an aluminium plate. The Drikold is either in contact with this aluminium plate or separated from it by means of one or more resistance pads, according to the rate of evaporation which is required.(17) The aluminium plate (which may be bent at the sides to any convenient shape) is cooled by the Drikold, and in its turn cools the air in contact with and surrounding it. The cooled air sinks and thus convection currents are set up, the hotter air rising to the top and coming in contact with the evaporator plate. In cases where special bunkers are not fitted in a vehicle, evaporator cartons can be used. These are hung as near the roof of the vehicle as possible. Each holds 25 lb. of Drikold and has four holes in each side covered with thin paper. A table on the carton indicates how many of these holes have to be uncovered for the various lengths of journey up to

42 hours. The number of cartons hung in a vehicle depends upon the weather conditions and the temperature to be maintained.

In the construction of a van or container there are several vital points which have to be watched:—

1. The Drikold unit must be placed as high as possible and, in any case, above the level of all goods to be refrigerated.
2. As far as possible, no bolts should be allowed to pass right through from the outside to the inside of the van, since this provides an excellent path for heat leakage. It has been stated that the conduction through a single 1-in. bolt is greater than that through a square foot of the normal insulation.(18)
3. Care should be taken to see that the van is gas-tight; otherwise there will be a continual leakage of cold air outwards and warm air inwards, thus imposing a higher load on the refrigerant. Properly fitting doors are necessary and care should be taken that any drains from the van floor are closed.
4. Enough room should be left around the load to allow adequate circulation. This is best done by means of battens on the walls and a grating on the floor.

The load may be either in a compact mass or, alternatively, spaced so as to allow free circulation of cool air amongst the perishables. The former practice is followed for most chilled and frozen commodities, whilst the latter is used for " live " perishables, such as fruit, flowers, etc., which are still breathing, and also for fresh meat and all commodities requiring cooling during transit. By " live " perishables are meant those in which respiration is still taking place and which, as a result, are evolving heat.

In the following pages a brief description is given of some of the results obtained with Drikold transport.

Fruit and Vegetables.—It has to be remembered that fresh fruits, vegetables and flowers even after gathering, are still living, breathing things, and that their respiration is accompanied by the evolution of heat which tends to warm up the mass. Further, it will be seen from Table I that the higher the temperature of the fruit, the greater is the evolution of heat. Columns 1, 2 and 3 are taken from data published by the U.S. Department of Agriculture(19) and Column 4, calculated from these data, shows that a considerable rise in temperature may take place during warm weather if fruit is loaded at atmospheric temperature and no special means of cooling is provided.

[TABLE

TABLE I

Evolution of Heat due to Respiration of Various Commodities

(1) Commodity	(2) Temperature °F.	(3) Heat evolved B.Th.U/ton/24 hrs.	(4) Consequent temperature rise if no cooling. °F. per 24 hrs.
Apples.	32	660— 880	0·3—0·4
	40	1,110— 1,760	0·6—0·9
	60	4,400— 6,600	2·2—3·4
	85	6,600—15,400	3·4—7·8
Cherries (Sour).	32	1,320— 1,760	0·7—0·9
	60	11,000—13,200	5·8—6·9
Grapes.	35	660— 1,100	0·3—0·6
	60	2,200— 2,640	1·1—1·3
	80	5,500— 6,600	2·8—3·4
Lettuce.	32	638	0·3
	40	7,392	3·5
	60	22,660	10·5
Peaches.	32	850— 1,370	0·4— 0·7
	40	1,440— 2,030	0·7— 1·0
	60	7,260— 9,310	3·5— 4·5
	80	17,930—22,460	8·8—10·5
Raspberries.	35	4,400— 6,600	0·2— 0·3
	60	15,400—17,600	7·8— 8·9
Strawberries.	32	2,730— 3,800	1·3— 1·8
	40	5,130— 6,600	2·5— 3·2
	60	15,640—19,140	7·6— 9·3
	80	37,220—46,440	18·0—22·4
Tomatoes (mature green)	32	0	...
	40	132	0·1
	60	2,574	1·2

Normally in Great Britain, soft fruits (raspberries, strawberries, etc.) are transported from the grower to the consumer immediately after picking, and the fruit is loaded into vans often at quite a high temperature, although, of course, the temperature of loading depends upon the weather. Table II below gives the average loading temperatures for fruit in the Carse of Gowrie and Norfolk for 1935 and 1936.

TABLE II

Summary of Raspberry and Strawberry Drikold Transport Results
1935 *and* 1936

(1) District and Fruit	(2) Season	(3) Average net wt. of fruit Cwt.	(4) Temp. of fruit on loading °F.	(5) Temp. of fruit on unloading °F.
Carse of Gowrie Raspberries	1935	30	64—84	44—61
	1936	30	57—68	46—58
Norfolk Strawberries	1935	40	63—89	52—74
	1936	30	57—76	46—61

Column (5) of the above table shows the temperature at which the fruit was unloaded from specially designed Drikold cooled containers belonging to the L.M.S. Railway Co. An important point that arises where fruit has to be cooled, is the choice of the best method of packing the fruit so as to get efficient cooling on the journey. It will be noted that the 1935 strawberries on unloading were somewhat higher in temperature than the average for raspberries for that year—this was because the load in each container was too great for efficient cooling. In this particular case, an average of 40 cwt. net of fruit was carried as against an average of 30 cwt. net in all the other cases. It will be seen that if this weight per vehicle is not exceeded, it is possible, by careful loading, to cool all the fruit down to a temperature range of 45°F. - 60°F. (7°C - 15·5°C). Judging by experience gained during the past two years, this should be quite satisfactory. Indeed, taking 1936 results when the loading temperature was only moderate, the percentage of Drikold refrigerated fruit which was available for canning (assuming the remainder was made into jam) was considerably higher than in the case of non-Drikold refrigerated traffic; the average improvement was 14% in 1936.

In connection with the transport and storage of fruit, it is interesting to note the following remarks made by Sir Frank Smith, the Chairman of the Food Investigation Board, in his report for 1935(24) which has recently been published:—

"There is an undoubted demand for better conditions in the transport and storage for a few days of soft fruits, such as the strawberry and the raspberry. The necessary knowledge is available. The requirements are, sound fruit, immediate cooling to a temperature of about 40°F. and the avoidance of condensation of water. The problem is how to accomplish this at a cost which the industry can afford."

The data that have been given above show that the demand can be satisfied. Those results which have been obtained during two years running of an experimental Drikold refrigerated service by the L.M.S. Railway Co. for fruit in specially equipped containers show that the cooling can be done during a journey of 14 hours, whilst experiments carried out in 1936 indicate that the fruit can be kept in excellent condition in the container for 45 hours, and probably for 60 hours. Further experiments in this field will doubtless be carried out during 1937.

Regarding the temperature of transport or short-period storage, it is considered that 40°F. is rather on the low side and that a temperature of 45°F - 50°F. is to be preferred, in order to avoid the condensation of moisture (often known in the trade as sweating) on the cool fruit on removal from the container into the market or factory atmosphere.

So far, no mention has been made of fruit for the retail market. Consignments of raspberries, strawberries, cherries, etc., have, however, been made from the producer to various markets; in many cases a higher price has been realised for the fruit and, as a result, an immediate demand was made by the wholesale merchants for more fruit to be carried by this method.

The storage of fruit at the market has also been studied, and some interesting experiments have been conducted with Drikold in this connection. The experiments were carried out in two adjacent cellars which had normally been used for the storage of a wholesaler's fruit stocks from day to day. The test cellar was boarded off and draught tubing placed round the door to minimise the leakage of cool air. Four Drikold evaporator cartons were hung in the test room daily. The results are shown in Table III.

TABLE III

Fruit Storage Results

(1) Time	(2) Start Wednesday	(3) 2nd day Thursday	(4) 3rd day Friday	(5) 4th day Saturday	(6) 5th day Sunday
Test store Temp. °F.	64	62	61	63	64
Control store Temp. °F.	66	69	70	75	76
External Temp. °F.	68	68	75	84	85
Weather Conditions.	Warm.	Warm.	Hot and Thundery.	Hot and Thundery.	Hot and Thundery.

The effect of storage on the various classes of goods was as follows:—

Tomatoes.—A case of fully ripened tomatoes was found after three days in the test store to be in very good condition, the gloss not having been affected in any way. Under normal conditions these tomatoes could not have been stored.

Strawberries.—Several chips of fruit were placed in the test store on a Wednesday, and a similar number of chips in the control store where there was no Drikold. All this fruit was what remained unsold from Wednesday's wholesale market. On Thursday, all the fruit in the control store was "off" and unsaleable, whilst the fruit in the Drikold Test Store was in admirable condition. Some of it was removed and sold on the market, the remainder being left in the test store. The fruit was examined daily, no change being noticed in either aroma or flavour. On the fifth day (Sunday), the berries were still perfectly firm and glossy, with a good aroma but a very slight change in flavour. It was impossible to state exactly what the difference was, but more than half the wholesaler's staff stated that the new flavour was preferable to the original. At the same time as this prolonged test, there were daily quantities of fruit passing through the store. On the Friday, for example, owing to the hot weather and the incidence of thunder, 200 lb. of strawberries were put in the store—this was the remains of a glut of good fruit at a low price. The next day supplies were poor in quality and quantity, and the fruit stored overnight in the Test Room was vastly superior to it. Some of this was sold, the remainder being kept until the Sunday. All the fruit was then removed and sold at a handsome profit; owing to the weather, it was practically the only good fruit available on that day in the district.

Melons.—On the Wednesday, 10 French melons were placed in the test store and two in the control store. The melons were very ripe, and it was feared that they might become a total loss. Those in the control store went bad, one on the Thursday and the other on the Friday, whilst the melons in the Drikold store were in good condition till sold, some being sold on the Friday and some not till the Sunday. In view of the success of this experiment, the wholesaler put over 36 melons into store on the Thursday and a further 84 on Friday. These were all sold very satisfactorily, the last being sold on the Sunday.

It is estimated that the maximum gas concentration was about 7% or 8% CO_2 falling perhaps to 1% or 2% when the doors were opened for loading into or discharging from the store.

The success of this experiment definitely leads one to suspect that a lowering of temperature is not the only contributing factor, and that a slight concentration of CO_2 helps considerably. This is borne out by the data obtained by the United States Department of Agriculture, who investigated the results of short-period carbon dioxide treatments for more than 40 different fruits and vegetables and summarise their results as follows:—(20)

"Decidedly favourable results were obtained with carbon dioxide treatments of sweet cherries, plums, peaches, Bartlett pears, raspberries, dewberries, blackberries, figs, grapefruit and oranges. Fruit that was exposed to carbon dioxide had less decay and was firmer and fresher than similar fruit held at the same temperature without exposure to CO_2. Initial carbon dioxide treatments at the temperatures that commonly prevail in a freshly loaded refrigerator car usually had as favourable an effect in retarding decay and in holding the firmness of the product as immediate storage at 32° F. (0°C).

Most of the products mentioned were exposed for two days to relatively high percentages of carbon dioxide without injury to flavour, but there were a few that failed to stand such prolonged treatment. Cuthbert raspberries were not injured by exposure to 30 to 40 per cent of carbon dioxide at the temperatures used for 29 hours, but developed an objectionable flavour when the treatment was extended to 48 hours.

On oranges and grapefruit, *Penicillium digitatum* and *P. italicum* were held in check better than *Diplodia natalensis* and *Phomopsis citri.*

Carbon dioxide retarded the ripening of tomatoes and also the development of certain types of decay, but tomatoes exposed to high percentages of carbon dioxide sometimes failed to ripen satisfactorily upon removal.

Cabbage, Chinese cabbage, broccoli, cauliflower, kohlrabi, collards, spinach, turnips, beets, corn, Iceberg lettuce, ripe bananas, avocados, and papayas were not injured by either of these treatments. The carbon dioxide seemed to decrease the bitterness in the Iceberg lettuce and to improve the flavour of the avocados and papayas.

Exposure to carbon dioxide delayed the development of *Phomopsis vexans* from eggplant and of *Sclerotium rolfsii* and *Rhizoctonia solani* on beans, but not that of *Colletotrichum lindemuthianum* and *Bacillus carotovorus* on beans.

The freshness of asparagus appeared to be maintained as well by exposure for 18 to 24 hours to 25 to 30 per cent of carbon dioxide at 60°F. or 70°F. (15°C or 21°C) as by immediate storage at 32°F. or 40°F. (0°C or 4·5°C), but more severe treatments sometimes affected the flavour of the tips of the stalks.

Initial carbon dioxide treatments held carrots in as sweet and fresh condition as immediate storage at 32°F. (0°C). The carbon dioxide had a decided checking effect upon decay resulting from inoculations with *Sclerotinia sclerotiorum* and *Rhizoctonia Sp.*, but not upon decay caused by *Bacillus carotovorus.*"

It should be pointed out that it is almost impossible under commercial conditions to get a concentration of CO_2 in a van or container higher than 15 to 20%, and concentrations exceeding 10% rarely occurs.

Owing to the advantages obtained from the use of solid carbon dioxide, shipments of fruit have been carried out from Central Europe to Great Britain in specially light containers (3 to 4 tons capacity) insulated with 6-in. Alfol and fitted with a thermostatically controlled Drikold unit (21) arranged to regulate the temperature inside the container to about 41°F. (5°C). Successful 6-day shipments have been carried out with strawberries, peaches, melons and grapes.

Flowers.—During the last year or two, a considerable amount of research work has been carried out with a view to discovering what benefits, if any, Drikold refrigeration and/or the gas storage effect of CO_2 can offer in the flower trade. Laboratory work has shown that a lowering of temperature and a 4% CO_2 concentration would each, by themselves, be beneficial to flowers and that when the two are combined the effect is considerably better than either alone, resulting in a generally increased " hardness " of the flower. Commercial trials have also been carried out, and some of them are described herewith.

In the transport of flowers, there are two possible ways of using Drikold:—(*a*) In Drikold evaporator units where large quantities of flowers are being carried at one time to one destination in a van or container; (*b*) in individual boxes of flowers where less than a container or van load is being sent.

Most of the work so far has been on flowers in boxes, although good results were obtained with two consignments of flowers in water to flower shows. A load of Delphiniums (450 to 500 spikes) was carried on a ten-hour journey from the nursery to the Royal Agricultural Society's Annual Show at Bristol. The firm concerned was well satisfied with the results, since the flowers were in much better condition than could have been obtained by ordinary methods.

A special case of roses in water was carried on a journey of 15 hours to the Royal Lancashire Show at Blackpool. On arrival, the treated roses appeared to be in much better condition than the untreated roses. There was, however, no increased life of the flowers.

In the treatment of individual boxes of flowers with Drikold considerable progress has been made. Usually ½ to 1 lb. of Drikold in a small insulated carton is fastened to the lid of the box and a small pad of cotton wool is placed between the carton and the stems of the flowers. Where this method is used, the preservation is due not to the cooling effect, which is negligible, but to the CO_2 gas concentration.

Normally flowers are cut about 24 hours before despatch and allowed to stand in water for 10 to 20 hours or longer before packing. This process is known to the trade as hardening. It is probable that for good results with Drikold, the hardening period has to be considerably shortened, from two to four hours being sufficient.

The results of eleven different commercial tests from the Channel Islands, the Home Counties and Lincolnshire to Covent Garden and provincial markets with different varieties of Iris, Carnations, Tulips, Stephanotis, Smilax, Gladioli and Peonies showed promising results in all cases except Stephanotis.

Further work is being done early in the 1937 season, in the course of which it is hoped to confirm the 1936 results, namely that with the use of Drikold—(*a*) all flowers will arrive at the market in a better condition than formerly; and (*b*) in many cases the life of the flower will be lengthened.

Beef, Mutton, Pork.—It has already been seen that a reasonable carbon dioxide atmosphere is an excellent preservative for fresh beef and mutton. During transport, it is quite possible for the " bloom," that indefinable quality which matters so much in the sale of meat, to be impaired, more particularly in warm, or damp, " muggy " weather. Under these conditions, water ice cooling is often inadequate, since it cannot provide a dry atmosphere for the meat during the journey, whereas Drikold refrigeration provides a dry atmosphere, the moisture in the air becoming snow or frost on the evaporator plate. Further, there is the good "antiseptic" effect of the CO_2 gas, which is all the more valuable under conditions of high humidity, since it is under such conditions that moulds and bacteria flourish best. Under actual commercial conditions it would be impossible to reach the CO_2 concentration at which damage might occur, more particularly as the journey in Great Britain never exceeds about 30 to 36 hours at week-ends, and at other times will usually be no longer than 12 to 18 hours. Often the meat is loaded into the van or container warm, and in warm summer weather, or in "muggy" weather, ventilation will not efficiently cool down and "set" the meat in the way which can be achieved in cooler, drier weather—this is where the cooling by Drikold can be as valuable as the gas atmosphere which it maintains in the vehicle. Commercial tests carried out over a week-end (36-hour journey) with mutton and beef have shown that the meat arrives in excellent condition, whilst on two occasions when long sides of beef have been carried with Drikold, it has been stated that the higher prices obtained at Smithfield for the beef more than justified the cost of Drikold refrigeration.

With pork and bacon, the concentration of CO_2 does not matter, even if it is 100%, since no damage results. Some experiments carried out at the Low Temperature Research Station, Cambridge, showed that amongst other things "After 70 days' storage in 100% CO_2, the pork tasted better than fresh pork because it was more tender."(22) A considerable traffic in pork and bacon by means of Drikold refrigeration is being developed, since it has been shown on trial to give excellent results.

Large quantities of Drikold are used in the transport of frozen and chilled mutton and beef, etc., from the dockside to the distributors' cold stores.

Rabbits, Poultry, Game, etc.—Considerable dissatisfaction is often expressed at the bad condition in which rabbits and poultry arrive at the wholesale market. This low quality is reflected in the price obtained; indeed, at one period during warm weather late in September, so many rabbits were condemned on arrival that the supply of English rabbits to the market practically ceased until the end of the warm spell. Experiments carried out with Drikold in containers and vans showed, however, that the rabbits could be transported satisfactorily by this means whatever the weather conditions. It was found that the gas storage effect was more important than any refrigerating effect. The rabbits arrived in very good condition, a noticeable feature being that not only were there no flies in the Drikold cooled van, but further, that even after removal of the carcases from the van none approached the treated goods for several hours.

It has been possible to obtain large enough quantities of rabbits at a time or to bulk quantities so as to obtain a van load. With poultry, however, this is impossible except in one or two isolated instances, and it is also impossible, owing to the open slatted box in which it is packed, to deal with it by individual boxes as is done with flowers. An insulated box was, therefore, designed to carry 12 crates of poultry, with which very successful results have been obtained. Unfortunately, however, the weight of the insulated box renders the freight prohibitive.

Fish.—It has already been stated that Drikold is not thought to be of any use on board a trawler, but where the transport of fish is concerned there are a few important applications of use to the fish trade.

Wet fish is usually transported in boxes with water ice, and it has been found by experiments in Great Britain that Drikold can be of no use here, since, in any case, some water ice has to be mixed with the fish. It is of interest, however, to note in passing that in Germany dry ice is being used for the transport of wet fish in railway wagons from Bremerhaven to the inland towns. It is stated that from 20 to 40% saving in water ice is obtained, quantities of from 45 to 165 lb. of dry ice being used on journeys of from 12 to 72 hours' duration in the large insulated *Kuehlwagen* and *Seefischewagen* on this service. It is claimed that "consumers without exception praise the new process and want to make further use of it." (23)

In the case of dried fish, particularly kippers, water ice cannot be mixed with the fish, and further, a moist atmosphere is not advisable. In hot weather a box of kippers, if it gets too warm, will become oily and the oil out of the kippers will soak into the wood of the box, giving the package a most undesirable appearance. This has been obviated by carrying the kippers in Drikold cooled containers. A considerable and increasing traffic of this type passes from the north-east and north-west coasts of Scotland to Billingsgate, the fish arriving in excellent condition. This system is particularly valuable at week-ends, when in some cases the container or van may be standing out in the open, exposed to the warm summer sun before unloading begins.

A considerable amount of frozen fish (chiefly smoked) is exported from Great Britain to South Africa, Australia and other places, and in all cases Drikold refrigeration is now used to keep the fish below 15°F. ($-9{\cdot}5$°C) during transit from the fishing port to the port of despatch which may be up to 45 hours' journey. It is on record that the first shipment of Drikold refrigerated fish was stated to be bad on arrival in the Antipodes, and it was not until some time later it was discovered that what had been taken for a "bad" flavour was certainly a change in flavour but was in reality a "fresher" flavour which previously had been unknown and unassociated with this article.

There are many other perishables on which Drikold transport experiments have been made—mushrooms, suet, sausages, and cooked meats, tomatoes, milk, cream, ice cream, gelatine, cheese, yeast, etc. Enough has, however, been said to show that this method of transport, if properly applied, can be of great help to fruit-growers, stock-breeders, the fish trade and many others who are in charge of the nation's food.

In conclusion, thanks have to be expressed to the four railway companies, particularly the London, Midland and Scottish, and the many commercial firms, without whose interest and help in carrying out the experiments described, the progress reported in this paper would have been impossible.

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FLAX-GROWING IN SCOTLAND

I. CULTIVATION AND HARVESTING

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THIS article has been written with the sole object of assisting Scottish farmers who are, or who may become, interested in restoring the flax-growing industry to a permanent place in Scottish agriculture. The experiment of 1936 amply proved what has already long been known, that Scotland possesses both soil and climate suitable for the crop.

Half a century ago flax-growing in Scotland was at its height, some 900 acres being grown in 1887. Four years later the area under flax had dropped to 10 acres, and up to the war years this figure was seldom exceeded. In the years 1918 to 1920 the average acreage was 1320, and in the years 1921 to 1927 it was 400. Since then it has been very small. During the last ten years or so pedigree varieties of flax seed have been introduced into commerce, which give over 50 per cent higher yield of fibre. Considerable progress has also been made in the introduction of modern machinery for processing the crop. These improvements have enabled the grower to obtain a better return for his labours.

During 1936, an interesting and successful experiment in flax-growing was carried out in the counties of Perth, Fife and Angus. Twenty single-acre plots were grown on different soils in different districts. Seed for sowing the plots was supplied at £1 per cwt. and the harvested crop was bought back from the growers at £6 per ton. On the more suitable soil yields of from 2½ to more than 3 tons per acre were obtained, and the average yield from the whole experiment was 2 tons 4 cwt., giving a gross return to the farmer of £13, 4s. per acre. As the cost of growing and harvesting flax is much the same as that of growing oats, it will be seen that flax-growing may be quite a remunerative proposition.

Flax is a quick-growing crop, being in the ground approximately 100 days, and it has the advantage that it is usually ready for harvesting between the hay and corn harvests. Another advantage is that it is possible, if one so desires, to have the flax clear of the ground in time to sow rape as a catch crop.

Soil and Cultivation.—Flax can be grown successfully on most types of soil. Probably the ideal is a medium loam overlying a retentive subsoil, or, as the Irishman puts it, a field with a cool bottom. Soils which are definitely not suitable are those which will dry out in droughty weather, water-logged soils, and soils of such a heavy nature that it is difficult to secure a suitable tilth at sowing time.

It is not essential that the land should be in particularly good heart, as quite useful crops of flax can be grown on the medium and poorer soils. On such soils there is often less trouble from harmful weeds, which on the richer soils are sometimes inclined to grow too profusely. It is occasionally said that flax does best in coastal districts, but the 1936 experiment proved that a crop well above the average can be grown right in the heart of Scotland at altitudes up to and exceeding 500 feet.

During the last few years the oat-grower has been complaining in bitter terms of the uneconomic conditions under which he is forced to market the produce which the nature of his land compels him to grow. Fortunately flax is particularly well suited to take the place of oats in any part of the rotation. Where lea oats is grown it is suggested that up to half the break might profitably be devoted to flax cultivation instead. Provided that a suitable tilth is obtained, flax does well after lea. The crop is generally cleaner and the flax will resist "lodging" as well as, if not better than, the oats will. There is also the advantage that flax is not liable to attacks by wireworm. Where it is not desired to reduce the area under white crop, flax can be grown equally well on clean stubble ground.

Flax makes a very good nurse crop for young seeds, but if it can be avoided it should not follow a green crop, more especially one that has been grown with farmyard manure. The crop then grown may be bulky, but as a rule it will produce a fibre of poor quality.

Little is required in the way of manuring. Neither lime nor farmyard manure is necessary or in fact desirable. The former gives a dry harsh fibre, and the latter a coarse fibre lacking in quality. The crop is generally improved in quality by a dressing of 1—1½ cwt. per acre of muriate of potash, or its equivalent of potash salt or kainit. Applications of ½ cwt. sulphate of ammonia per acre will generally raise the yield on poorer soils, but this quantity should seldom be exceeded, as the quality of the fibre is almost sure to suffer. Ammonia is unnecessary on the better soils. The use of phosphates on flax has been said to encourage the growth of weeds. While this is possibly true, the use of 2 cwt. superphosphate per acre may not go amiss in Scotland, where the crop will be saved for seed as well as for fibre. It should help the seed yield and give even and earlier ripening in addition to checking any tendency there may be to lodging. All manures applied should be harrowed in with the seed.

Ploughing should be about 6 in. deep, and as flax does best with a stale furrow it is advisable to plough early. This is more important when flax follows lea, as full benefit can then be got from the frost mould.

Where there is a danger existing of the growth of weeds, it is often advantageous to work the ground partially about three weeks before sowing time, and thus encourage the weed seeds to germinate. The seedlings are then killed in the subsequent cultural operations. This is a very effective way of eradicating annual weeds. Land for flax is worked before sowing, the aim being to procure a fine firm seed-bed similar to that required for grass seeds. If the land is lumpy it should be rolled before sowing. When the sowing is completed the seed should be harrowed in with a light set of harrows and then rolled. As the seed should not be buried more than ½-in. to 1-in. deep, one stroke of the harrows after sowing is generally sufficient.

Sowing.—For Scottish conditions it will be found that the month of April is the most suitable time to sow flax, but whether early or late in the month will depend on the season and the district. The normal rate of seeding varies from 90 to 100 lb. per acre, depending on germination. On suitable lands up to 1 cwt. per acre may be sown. Thick sowing tends to give less seed but produces fine-stemmed plants giving a large yield of fibre per acre of high quality. Even distribution of the seed is important in order to get a uniform crop. Flax seed being comparatively small and exceedingly slippery requires to be sown with extra care. It may either be sown broadcast or drilled.

Hand-sowing is a method very satisfactory for small acreages, provided that one is experienced in the art of sowing by hand. A cast of 4 yards (*i.e.* 2 yards on either side) gives very good results. The seed must be gripped tightly in the hands. The full seeding may be applied at once, but the slippery nature of the seed causes an undue amount to fall at the sower's feet. A much better job is made if only half the quantity of seed is sown at a time, and the remaining half sown across the first. In Northern Ireland it is customary to sow flax with a " fiddle," but this machine is not much used in Scotland.

Broadcasting by machine is the method recommended for large acreages, but more than usual care is required to ensure a satisfactory result. Very careful setting of the machine is necessary. It is useless to attempt sowing flax with a leaky, badly-worn machine, as the seed will run through it like water. For this reason also it is important that the outlet holes should never be open unless the machine is in motion. Inattention to this detail may easily result in the loss of large quantities of seed. All bumping over uneven ground also shakes out extra seed.

By using a " seeds " drill, an implement practically unheard-of in Scotland, flax can be drilled in 3-in. rows and a first-class braird procured. It is unusual to recommend a corn drill for flax, as 6-in. spacing is too wide. Such spacing would crowd the plants in the rows and tend to give stems of uneven thickness, which is undesirable. Where, however, there is the possibility of the crop being badly infested with weeds, such spacing can be advantageous, as it allows for weeding between the rows.

When flax is from 4 in. to 6 in. high, it is necessary to go through it and pull out all tall-growing weeds such as thistles, docks, fat hen, skellochs, etc. It is better to avoid growing flax on land subject to Red Shank, as this weed causes trouble in the later stages of linen manufacture. Should this weed be present, it is advisable to harrow early as mentioned above.

Weeding must be attended to promptly as the flax grows rapidly at this stage, and failure to weed only results in much extra trouble and delay at harvest time.

Harvesting.—Flax is ready for harvesting when the lower half of the stem becomes yellow and has lost its leaves. At this stage, if a capsule is broken open and the seed examined, it will be found that the tips of the seeds are just beginning to turn brown. The ripening process continues after the flax is pulled. It is a mistake to allow the crop to become over-ripe. By harvesting at the stage indicated, one is assured not only of fibre of high quality but, if properly saved, of good germinating seed in addition.

Well-harvested flax should be of a uniform primrose colour and tied up free from weeds in medium-sized sheaves which have been well butted down so that their root ends are all even. The secret of success in achieving this lies in (*a*) careful handling and (*b*) slow drying without exposure to strong sunlight, both of which can be carried out even in bad harvest weather.

It is usual to pull the crop by hand, a task not nearly so formidable as one would imagine. Experienced pullers can clear ¼ acre per day, so a beginner would have no great difficulty in pulling an acre per week. As the crop is pulled it should be spread in regular rows alongside the pullers. After, say, two days, during which the straw will have stiffened considerably, or when it is reasonably dry, it should be tied up in sheaves, the top (or dry) side going to form the inside of the sheaf. After tying, the crop should be stooked. A few days later, or as soon as the heads feel superficially dry, the flax should be built round a tripod (three-legged boss) to form a ventilated hut. Usually from 5 to 7 huts are put up to the acre. In properly-made huts the flax is given time to mellow and mature without being exposed to damage by bright sunshine or continuous washing by rain. After a month to six weeks in huts, the flax is ready for de-seeding or stacking.

Should it be thought advisable to turn the rows of pulled flax before tying into sheaves, this is easily accomplished by inserting the shaft of a fork or rake beneath the flax and inverting a length at a time. It may also be found necessary to turn the stooks before hutting, and, if so, care should be taken not to tangle the heads.

It may be helpful and not out of place to give a few hints on some "Don'ts" during harvesting:—

(1) Don't pull weeds with the flax.
(2) Don't leave flax lying on the ground exposed to light and weather until it becomes discoloured.
(3) Don't omit to keep the root ends level when tying into sheaves.
(4) Don't leave standing in stooks longer than is necessary.
(5) Don't build big huts without ventilation holes.
(6) Don't be tempted to stack the crop without hutting. Nine times out of ten it will go bad in stack; if it does not, it has probably been too long in the stooks.
(7) Don't throw flax about like hay. Remember the straw is valuable, so don't spoil it.

Probably in the near future hand-pulling will have to give way to speedier and less costly methods of harvesting. Already mechanical pullers and modified reapers are being tried. While it cannot be said that either is yet a commercial success, they have given quite promising results. By cutting, of course, less weight of crop is obtained, and there is always the trouble that weeds are mixed in with the flax. Another difficulty arises from the way in which the heads of the flax cling together and so make it troublesome to separate the cut flax from the standing crop. This difficulty is to a certain extent alleviated by cutting the crop when it is bone dry.

The Future of Flax-growing.—In Northern Ireland, which is the home of flax-growing in the British Isles, it is customary for the farmers to process their own flax straw. This has become a lost art in Scotland, and it is questionable if it would ever pay to revive it.

It is fairly certain that there will always be a demand from Northern Ireland for pedigree flax seed, as it is the exception rather than the rule to save seed in that country. It is very doubtful, however, if in a normal year it would pay to grow flax for seed alone. In fact, unless there is also an assured market for the straw it would be very unwise for any Scottish farmer to grow flax hoping to make a profit from it. At present there are three principal methods by which flax straw may be processed. These are (*a*) water retting, which produces the line fibre of the highest quality, but is a costly process necessitating a high initial capital expenditure; (*b*) decorticating, which eliminates the costly retting process and produces a green fibre. It is thought this will be very suitable for the Scottish trade, but as yet it has hardly gone beyond the experimental stage; (*c*) dew retting on the farm and the manufacture of tow, which is a system highly adaptable to mass-production methods. It is being tried on a large scale in Scotland this year, and if it is successful a large expansion of acreage may be looked for in the years to come.

Provided enough support is forthcoming, it should be quite possible to establish small factories in suitable districts for processing the crop by any of the methods indicated. One essential in the interests of the farmers as well as of the factory is that the crop must be bought on the basis of quality; only thus will the competent grower get his just reward.

Meantime it has been proved that flax of high quality can be successfully grown in Scotland. It therefore rests with Scottish farmers to further their own interests by expressing their willingness to grow more flax.

TABLE I

Costs of Production of Flax per Acre 1936 in East of Scotland

Arranged in order of Yield per Acre

Farm No.	1	2	3	4	5	6	7	8	9	10	Average of 10 farms
Type of Soil	Clay Loam	Medium Loam	Medium Loam	Medium Loam	Medium Loam	Medium Loam	Light Loam	Medium Loam	Medium Loam (wet)	Light Loam	
How pulled (C=contract labour, F=own farm labour)	F	F & C	F	F	F	F	F	Mainly F	C	C	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Costs per acre											
Labour — man and horse ploughing	1 0 0	0 16 3	0 13 0	0 13 0	0 13 0	0 13 0	0 13 0	1 0 0	0 13 0	0 13 0	0 14 9
Harrowing, rolling, sowing, etc.	0 12 0	0 5 8	0 5 1	0 6 6	0 9 11	0 8 7	0 5 2	0 10 0	0 14 7	0 7 2	0 8 6
Weeding	...	0 11 8	...	0 4 0	0 5 0	0 1 6	0 6 0	...	0 1 0	1 13 0	0 6 2
Pulling, tying and stooking ...	3 11 0	2 16 8	4 5 4	6 15 0	3 10 0	5 0 0	3 10 0	2 10 0	3 5 0	3 0 0	3 16 4
Hutting, carting and cleaning land	1 0 0	1 5 3	0 12 8	1 5 10	1 2 6	0 19 5	0 11 6	0 10 0	0 19 9	1 5 6	0 19 3
Total Labour ...	6 3 0	5 15 6	*5 16 1	9 4 4	6 0 5	7 2 6	5 5 8	4 10 0	5 13 4	6 18 8	6 5 0
Rent	2 7 6	1 8 0	0 14 6	1 2 6	1 2 6	2 2 6	1 0 0	0 10 0	1 12 6	1 5 0	1 6 6
Seed	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0
Manures (less unexhausted manurial residues)	0 10 3	0 5 3	...	0 3 9	0 7 6	0 5 10	1 7 2	...	0 19 3	0 16 2	0 9 6
Establishment Charges	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0
Total Costs ...	11 0 9	9 8 9	8 10 7	12 10 7	9 10 5	11 10 10	9 12 10	7 0 0	10 5 1	10 19 10	10 1 0

*** Adjusted figures : ploughing and certain other cultivations were performed by tractor, more cheaply than shewn above ; in order to make these costs comparable with those of other farms, horse labour costs were substituted.**

TABLE II

YIELDS, RETURNS, ETC., OF FLAX PER ACRE 1936 IN EAST OF SCOTLAND

Arranged in order of Yield per Acre

Farm No.	1	2	3	4	5	6	7	8	9	10	Average of 10 farms
Date of sowing—approx.	April 6	April 10	Early April	April 8	April 3	April 2	April 1	April 22	May 15	April 6	
Previous Crop	Turnips	Grass	Grass	Grass	Grass	Grass	Turnips	Grass	Wheat	S. Beet	
Total Costs per acre	£ s. d. 11 0 9	£ s. d. 9 8 9	£ s. d. 8 10 7	£ s. d. 12 10 7	£ s. d. 9 10 5	£ s. d. 11 10 10	£ s. d. 9 12 10	£ s. d. 7 0 0	£ s. d. 10 5 1	£ s. d. 10 19 10	£ s. d. 10 1 0
Yield per acre	T. c. q. 3 1 0	T. c. q. 2 17 2	T. c. q. 2 15 0	T. c. q. 2 14 2	T. c. q. 2 10 0	T. c. q. 1 19 2	T. c. q. 1 12 2	T. c. q. 1 6 0	T. c. q. 1 4 2	T. c. q. †	T. c. q. * 2 4 3
Returns per acre	£ s. d. 18 6 0	£ s. d. 17 14 7	£ s. d. 16 10 0	£ s. d. 16 7 0	£ s. d. 15 0 0	£ s. d. 11 17 9	£ s. d. 9 15 0	£ s. d. 7 16 0	£ s. d. 7 6 3	£ s. d. ...	£ s. d. *13 8 1
Profit or Loss per acre	Profit 7 5 3	Profit 8 5 10	Profit 7 19 5	Profit 3 16 5	Profit 5 9 7	Profit 0 6 11	Profit 0 2 2	Profit 0 16 0	Loss 2 18 10		Profit * 3 9 3
Artificials applied per acre (cwt.)										None; charge shewn in Table I is for residues from previous crop	
Superphosphates	3	1½	...	...	...	2	..	...	2		
Muriate of Potash	2	1	Nil	1	2	1	1½	Nil	1¼		
Sulphate of Ammonia	..	...	...	...	...	...	...	...	¾		
Ground Mineral Phosphates ...	...	...	...	...	...	..	...	...	½		

† Crop rejected by the F.S. and M.A. and not yet marketed through the alternative outlet which is expected for it; the yield is estimated at 2 tons.

* Yields, Returns and Profits per acre are averaged for 9 farms only instead of 10, as may be understood from the note above.

II. COSTS AND RETURNS

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THE year 1936 saw the re-appearance of flax as a crop on quite a number of farms in the East of Scotland, in part due to a small experiment undertaken by the Flax Spinners' and Manufacturers' Association of Dundee in collaboration with a few farmers in Angus, Fife and Perth; and in part due to a more ambitious project under the auspices of the Blairgowrie branch of the National Farmers' Union aiming primarily at the production of pedigree flax seed. It is solely with the former experiment that this brief note on the cost of flax-growing deals.

The Association, desirous of ascertaining whether flax could be grown profitably as a farm crop in Scotland (thus ensuring local manufacturing industry of the supply of part of its raw materials almost at its doors), purchased 1 ton of flax seed, costing £70, for distribution in cwt. lots at £1 per cwt. among interested farmers—*i.e.*, 50s. per cwt. below cost price. Altogether 20 acres were grown under their auspices, in all but two cases in 1-acre plots. The details appended relate to those growers situated in the area served by the Edinburgh and East of Scotland College of Agriculture, 5 of them being in Fife in the neighbourhood of Cupar and Dunfermline, 3 in Angus, and 2 in Perth. The average costs of production per acre on the 10 farms were as follows:—

	£	s.	d.
Labour—Ploughing	0	14	9
Harrowing, rolling and sowing	0	8	6
Weeding	0	6	2
Pulling, tying and stooking	3	16	4
Hutting and carting, and cleaning land	0	19	3
Total Labour	6	5	0
Rent	1	6	6
Seed	1	0	0
Manures (less unexhausted manurial residues)	0	9	6
Establishment Charges	1	0	0
Total Costs	£10	1	0

The appended tables summarise the costs of production on each of the farms, besides giving relevant data concerning yields, financial returns, profits, etc. (see pages 2 and 3).

Production Costs.—It will be seen that the total costs averaged £10, 1s. per acre, ranging between the limits of £7 an acre and £12, 10s. 7d. As might be expected, labour formed the principal item of cost, averaging £6, 5s. per acre but shewing considerable variation from farm to farm. These costs include all proper charges for man and horse labour for cultivating, harvesting, and carting the crop, calculated at the uniform rates of 6s. per day for a man, and 3s. 6d. per day for a horse (except where work was undertaken on contract); in one case where ploughing and certain other cultivations were performed more cheaply by a tractor, horse labour costs have been substituted to make the figures strictly comparable with those of other farms.

The major item of labour costs was the hand-pulling, tying and stooking of the crop in late July or early August. Only on two of the ten farms was the crop pulled entirely by contract labour, most of the farmers employing their own staff for the purpose, and spreading out the work over a period of several days. Generally speaking, little difficulty was experienced by them in undertaking this vital task; but in one or two cases it proved very irksome, long-drawn out, and costly, so that the job could have been done more speedily, efficiently and cheaply by the hiring of skilled labour on contract. After being pulled, tied, and stooked, the crop usually stood in the stooks for a fortnight or so, after which it was erected on tripods (hutted) or carted to the stackyard. Later still, about October, it was lifted by lorry and taken to Balmossie, Dundee, to be de-seeded, the straw then being dispatched to Northern Ireland to be retted by the Linen Industry Research Association, Lambeg, and sold through the usual channels; the flax from one or two farms was, however, dispatched to Norfolk, seed and all. In all cases all transport costs from the farm were shouldered by the Association, regardless of the destination of the crop.

It will be noted that only in one case had a considerable amount of weeding to be done; three of the farmers, in fact, found weeding entirely unnecessary. Nor was the land left in a very dirty state after the removal of the crop. Contrary to general expectations it was, in several cases, as clean as adjacent land under oats; where necessary, however, a small charge for cleaning has been included in the costs according to the circumstances of the farm, in no case exceeding 10s. per acre.

Generally speaking, labour costs are high, but offer scope for economies which could be made by the hiring of skilled labour, or by better methods of handling born of experience.

Rents, averaging £1, 6s. 6d. an acre, vary between the wide limits of 10s. an acre for a rather late, high-lying Perthshire farm to £2, 7s. 6d. an acre on a small desirable Angus farm in good heart not very far from the coast, which returned the heaviest yield recorded—3 tons 1 cwt. per acre; this range demonstrates that the crop was grown under very varying conditions of soil and climate, so that, notwithstanding the relatively small number of farms growing the crop, they form a reasonably representative sample of the area, and give a fair picture of the possibilities of the crop under diverse circumstances.

Seed cost the growers £1 per cwt. Since 1 cwt. sows an acre of ground, the crop was, in effect, subsidised by the Flax Spinners' and Manufacturers' Association to the extent of £2, 10s. per acre. Some farmers sowed the seed by hand, others by a broadcast sowing machine. The crop was sown on most farms during the first fortnight of April; on one farm, where, owing to a variety of causes, it was found impossible to sow the seed until 15th May, the crop was definitely a failure—the only one amongst the ten farms.

Most of the growers gave their flax an application of artificial manures, although in three cases the crop received no fertiliser at all. Generally after grass (which flax in most cases followed) 1—2 cwt. of muriate of potash was applied, with or with superphosphate. The heaviest dressing of artificials—3 cwt. of superphosphate and 2 cwt. of muriate of potash per acre—was applied to flax grown after turnips, and probably contributed to the excellent flax yield obtained—3 tons 1 cwt. per acre; curiously enough, the next heaviest application was given to the one crop which turned out a failure. In arriving at the cost of manures chargeable to the flax crop, the unexhausted manurial residues have been deducted according to the standard scales published by the Department of Agriculture for Scotland: some doubt may perhaps be entertained as to the correctness of this procedure in view of the reputed exhausting nature of the flax crop, and the considered opinion of local agriculturists of wide experience differs on this point. Had the full cost of artificials applied to the flax been charged entirely to this crop, no residues at all being carried forward, it would have raised the average cost per acre by 6s.

Establishment charges have been included at a uniform figure of £1 per acre; this is meant to cover such items as depreciation and repairs and renewals of farm implements, depreciation of horses, etc., the actual figure inserted being arrived at from a study of the farm accounts drawn from this area by the College in connection with other work during the past eight years. It is fundamentally sound that the flax crop should bear a reasonable portion of this heavy miscellaneous expenditure incurred each year on an arable farm.

Returns.—In due course all but one of the flax crops were lifted at the farm by lorries hired by the Flax Spinners' and Manufacturers' Association, and paid for at the agreed price of £6 per ton gross (for the straw and seed together), the one exception being a 2-ton crop which, though well won, had gone bad in the stack and was rejected by the Association's technical adviser. The grower's financial return per acre (but not his profit) therefore varied directly with the gross yield; the average costs, yields, and profits may be summarised as follows:—

Average cost of production per acre	(10 farms)	£10 1 0
,, yield per acre . .	(9 ,,)	2t. 4c. 3q.
,, financial return per acre	(9 ,,)	£13 8 1
,, net profit per acre .	(9 ,,)	£3 9 3

Yields per acre, averaging 2 tons 4¾ cwt., ranged from 3 tons 1 cwt. to 1 ton 4½ cwt.; five of the growers had yields of 2½ tons or over, whilst the other four had yields below 2 tons. The heaviest yield, and therefore the highest financial return per acre, was obtained from a field where the soil was a loam rather clayey in texture, in good heart, following a crop of turnips, the flax crop being sown early in April and liberally manured with 3 cwt. superphosphate and 2 cwt. of muriate of potash.

Gross financial returns averaged £13, 8s. 1d. per acre on the 9 farms, and ranged from £18, 6s. to £7, 6s. 3d., whilst five of the growers had a return of £15 per acre or over.

The average net return from the 9 farms was a profit of £3, 9s. 3d. per acre. Only one showed a loss, caused by the low yield secured, notwithstanding the liberal manuring, owing to the unsuitability of the soil, which proved to be cold and wet, and the lateness of the sowing. Five of the farms showed handsome profits of £3, 16s. 5d. upwards, in one case of as much as £8, 5s. 10d.; on the other three farms, profits were small, the growers only just covering their costs of production.

Conclusion.—On the whole, the crops grown by the ten growers whose costs have been dealt with in this brief report have fully justified the experiment, and demonstrated that flax, intended primarily for fibre, can be grown profitably as an ordinary farm crop in the East of Scotland. Provided that the Flax Spinners' and Manufacturers' Association are prepared, for the time being at any rate, to offer farmers the same terms as last year—*i.e.* seed at £1 per cwt., the crop to be purchased at £6 per ton gross—the crop should pay its way, since on good land growers have a reasonable chance of securing a crop of 2 tons per acre, a yield which fully covers their production costs. It should be noted that, even had they paid the full cost price of £3, 10s. per cwt. for their seed, five of the nine growers would still have more than covered their costs during the past year. Even a yield considerably below 2 tons per acre may, on the terms above quoted, more than make ends meet if, for instance, the rent is well below the average figure of £1, 6s. 6d. per acre shown in these costs or if labour costs are kept low, and it appears that, as has been the case with sugar beet, further experience would enable most farmers to cut down their costs of cultivating and harvesting the crop. Meantime, however, it is to be noted that notwithstanding the profit shown by their flax crop on paper, one or two growers are not very favourably disposed towards growing it another year, owing partly to its heavy labour requirement and seasonal difficulties connected therewith, and partly to the serious shortage of oat straw experienced on most farms this year—a matter of considerable importance to arable farmers carrying feeding cattle or a dairy herd. In the light of figures herein submitted it appears that, whilst recognising these difficulties, which arise from the interdependence of the complicated, inter-locking departments of a well-organised intensive arable or mixed farm in this area, the flax crop is worth persevering with if the promoters of the experiment are disposed to continue their financial arrangements on similar lines. It would be dangerous to dogmatise, however, from only one year's results, since entirely different weather conditions may rule in another season.

Grateful acknowledgment is hereby made of the valuable assistance given by all farmers who willingly collaborated in this investigation by keeping records of their flax crop and by giving other information, and by the Flax Spinners' and Manufacturers' Association who kindly furnished a list of the names of the growers and other useful data.

HUSKLESS OATS

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STATISTICS show that of all the cereal crops grown in Scotland oats occupy much the largest area. They are successfully grown under widely varying conditions ranging from those on the most fertile soils to those on poor upland soils lying at elevations of up to about 1000 feet above sea level. In general practice much of the grain is consumed on the farm by horses, cattle and sheep, either as whole or as crushed oats, and it makes excellent feeding. For feeding poultry and pigs, oats either whole or crushed are not so suitable on account of the husk or fibre they contain, but when only the kernel is fed in the form of oatmeal, oats give very satisfactory results, as, for example, in the rearing of chickens. The kernels of Scottish oats, according to analyses given by Berry, contain an average of about 7·73 per cent of fatty substances, whereas wheat kernel or grain contains an average of only about 1·9 per cent. The proportions of other nutritive substances in oat kernels and in wheat grain are not widely different. Oat kernels also contain a substance known as "Avenin" which, it is claimed, has a beneficial effect in stimulating the secretion of the digestive juices in the stomach and intestines. Oat kernels, therefore, compare favourably in feeding value with wheat. To eliminate the husk from oats as in making oatmeal or groats renders the product too expensive for poultry and pig feeding. Doubtless if oat kernels could be easily and cheaply obtained from oats there would be a place for the product on the market, particularly for the feeding of poultry and probably for that of pigs. The source from which it is easiest to obtain oat kernels without husk is a type of oat known as the Huskless or Hull-less oat, the grain of which threshes out in the same way as does ordinary wheat grain.

Huskless oats are by no means a new introduction. They appear to have been grown in England and in Ireland a long time ago, and are probably what was called "pilcorn." As in ordinary oats there are various types of huskless oats. Some have open spreading ears or panicles, while others have a tartarian or one-sided type of ear. The kernels of some are very small, not much larger than the kernels of ryegrass seed, while in others the kernels are as large as those in some of the ordinary husked oats. The main difference in appearance between grain of common or hulled oats and that of huskless oats is that in the former the kernel or groat is held tightly between two hard husks or hulls, which generally remain enclosing the kernel after the oat plants have been threshed; in the latter the kernel is similarly enveloped by two husks but not tightly held, since the husks are thin and of the same papery consistency as those parts of the oat head which the farmer knows as chaff. Hence when huskless oats are threshed in the usual way, the kernels, being only lightly held by the husks, come from the thresher in the same condition as wheat grain. The soft husks are blown out with the ordinary chaff which they closely resemble in appearance. An ear of a variety of huskless oat is illustrated in Fig. 1. An interesting feature of these oats is that frequently there are more than four grains in the spikelet (see Fig. 2), whereas in many of the hard-husked oats there are often only one or two grains in the spikelet, and seldom are there more than three. The huskless oat has therefore been frequently used as a parent by oat breeders with a view to raising the grain yield of hard-husked varieties by increasing the number of grains per spikelet. But results have been disappointing on that score and the desired goal has not yet been reached. One drawback has been that in general, whenever there were more than four grains in a spikelet, some of them were of the huskless type.

While a certain measure of success has attended the efforts to secure heavy grain-yielding, hard-husked varieties, much less success has been achieved in the efforts to secure improved varieties of huskless oats. It is well known that new varieties of huskless oats have been tried in this country from time to time, but so far none has been successful enough to be grown extensively. In 1936 a huskless oat was recommended and offered to farmers for trial on a commercial scale by a seed firm in England, but the writer has heard of only a few encouraging results having been obtained with it in Scotland. That season was not very favourable for growing and securing cereal crops, and better results may be obtained in a more suitable season.

Although the results in Scotland in growing huskless oats have on the whole not been encouraging, it is worthy of mention that two new varieties of huskless oats were put into commerce in Canada about twenty years ago and have been grown there on a commercial scale. A few notes regarding these two varieties, known as Liberty and Laurel, may be of general interest. Both of them were raised in the Cereal Division, Dominion Experimental Farms, Department of Agriculture, Ottawa, Canada.

Liberty was secured by crossing the Chinese Naked oat with the Swedish Select oat. It has been reported officially that the cross was made in 1903 and that the new variety was put into commerce in 1917. It was described as follows:—" Heads open; awns rare; kernels of about medium size. Ripens early. Straw stiff and rather long."

Laurel was obtained by selection from the progeny of a cross, also made in 1903, between Banner and Chinese Naked, and presumably it was introduced into commerce shortly after Liberty. It was officially described as follows:—" Heads open; awns very rare; kernels quite large (see Fig. 3); straw of medium length, stiff. This variety is not so early as Liberty but the kernels are larger, and the weight per measured bushel is greater than in the latter sort."

Reporting in 1924, the Dominion Cerealist stated with reference to these varieties (Liberty and Laurel) that " the absence of hull surrounding the kernel makes these varieties particularly attractive to the poultryman and the feeder of young growing stock, especially

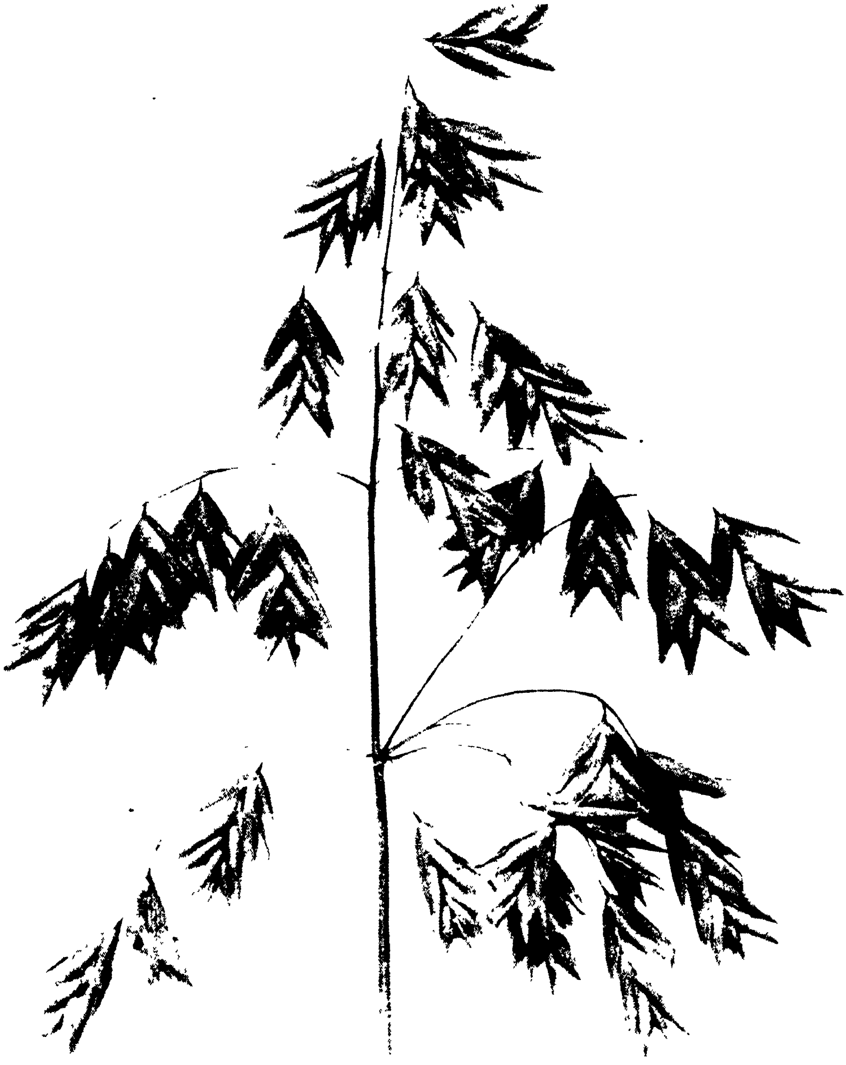

FIG. 1.—Panicle or Ear of a variety of Huskless oat.

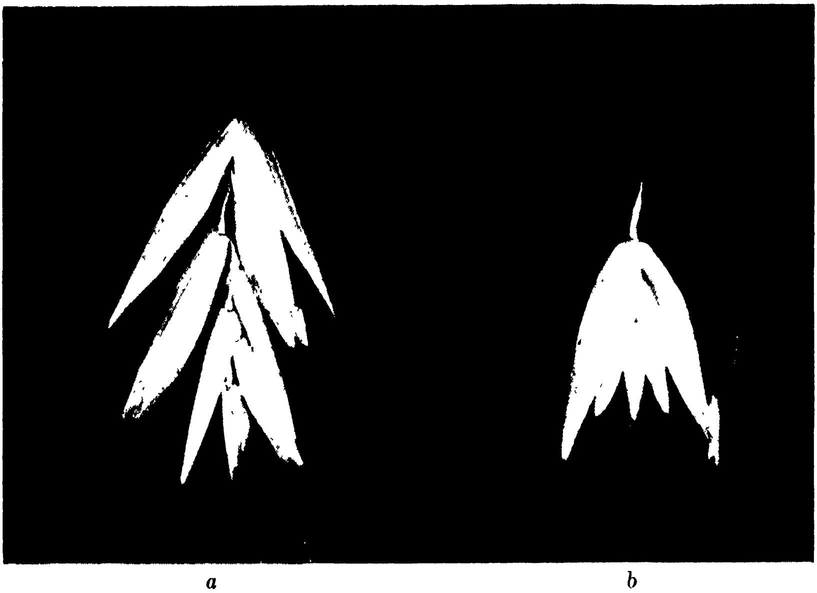

FIG. 2.

a Spikelet of Huskless oat with six grains.
b Spikelet of Hulled oat with three grains.
(Both slightly enlarged.)

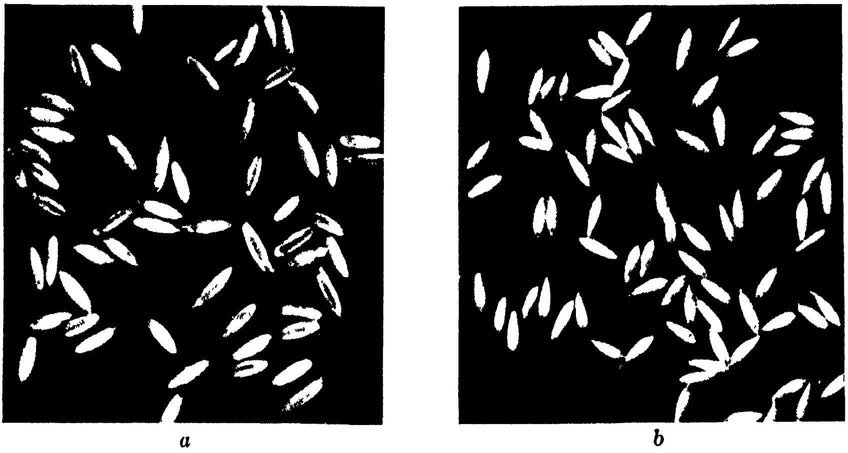

FIG. 3.

a Kernels of Huskless variety Laurel.
b Kernels of Potato oat.

pigs." In 1930 the Superintendent of the Experimental Station, Rosthern, Sask., reported that "Laurel, a high-yielding hulless variety, is being used quite extensively for pig and poultry feeding." At the Experimental Farms, Ottawa, over a ten-year period Liberty gave an average yield of kernel of 1390 lb. per acre and Laurel for the same period gave a yield of 1422 lb. as compared with a yield from Banner of 1624 lb. Expressed as percentages of kernel, taking Banner as 100, Liberty gave 85·6 and Laurel 87·6. In trials on irrigated land in Alberta, Laurel is reported to have given over a four-year period a yield of 69·8 bushels at 50·5 lb. per bushel (=31·5 cwt.) per acre as compared with 68·4 bushels at 37·6 lb. per bushel (=23 cwt.) from Victory, and 81·9 bushels at 34·5 lb. per bushel (=25 cwt.) from Banner. Reporting again in 1934, the Dominion Cerealist said—"Laurel, a hulless variety, is recommended generally throughout the Prairie provinces where an oat of this type is required. The yield per acre of Laurel is usually about 10 to 15 per cent under the best hulled varieties, after allowing for the 28 to 30 per cent hull of the latter sorts." Laurel seems to have consistently outyielded Liberty, and it appears that the latter is not now being grown in Canada.

In view of reports from Canada on these two varieties, observations have been made on small plots of them at the Scottish Plant Breeding Station, Corstorphine, for a number of years. The rate of seeding of these two varieties has been approximately the same as that of ordinary oats, viz. about 2½ million seeds per acre. In 1936 this worked out in the case of these huskless oats at about 132 lb. per acre. Seeding at this rate has never been found to give too thick a braird. In fact, in some seasons the braird has been too thin, suggesting that the germination of the seeds was not very vigorous. This doubtless seriously reduced the yield of grain. Irregularities in the braird sometimes occurred through the depredations of birds, which seem to have a liking for the seeds. Both varieties may be regarded as early ripening types, maturing at Corstorphine about a week or so earlier than either Potato or Victory. Liberty has slightly longer straw than Laurel; neither of them has shown any tendency to lodge during the past three years. The yield of grain obtained has varied considerably. This is shown in the following table, which gives the yields of kernel in hundredweights per acre, calculated from small trial plots of Liberty, Laurel, Victory and Sandy varieties grown at Corstorphine.

Year	Liberty cwt.	Laurel cwt.	Victory * cwt.	Sandy* cwt.
1934 .	11·7	10·3	24	20·5
1935 .	21·0	19·2	28	20·5
1936 .	19·7	17·6	28	18·0

* 1935 crop determinations—Victory 26%; Sandy 24% husk.

In 1934 the crops were thin and the yields very low. In 1935 much better yields of grain were obtained, but in 1936 the yields of grain were again lower. At Corstorphine Laurel has always given a slightly lower yield of grain than Liberty, thus differing from results obtained in Canada and incidentally showing that the relative grain yielding capacity of different varieties may vary in different districts. The braird of both the huskless oats in 1936 was thin and much more irregular than in any previous year, and consequently they ripened rather later. It is therefore apparent that these huskless oats do not give a yield of kernel comparable with that from Victory, or many other standard varieties, and that unless their grain can command a considerably higher price per cwt. they will be unable to compete successfully with the heavier grain yielding, hard-husked varieties. When compared with the old Scottish variety Sandy, however, their yields of kernel showed little difference in 1935 and 1936.

The tendency for huskless oats to shatter or shed their grain was not very noticeable in 1934 and 1935, when the weather at harvest time was favourable for securing cereal crops in good order. The huskless oats were cut with the scythe; they were stooked and handled in the usual way and little loss of grain was evident. In 1936 there was much wet weather at harvest and shedding of the grain was more apparent, but it was not any more pronounced than in the case of wheat, which was exposed in the stook to the same type of weather. A defect noted in these huskless oats was that they sprouted in the stook rather freely after the sheaves had got throughly soaked through during the wet weather. With average weather at harvest time it does not seem that serious loss should occur in huskless oats from shedding or sprouting. The liability to shed grain could probably be lessened if the crop were cut before it is dead ripe.

In growing Liberty and Laurel oats it has been very difficult to keep them pure or true to type. Each year plants with hard- and with partly hard-husked grains have appeared in the plots, even though care was taken to ensure that only huskless grains were sown. Other growers may also have noted the occurrence of these types of grain in their crops of huskless oats. These " off-types " have not occurred as a result of accidental admixture. Oats are normally self-fertilised and very little natural inter-crossing takes place between hard-husked (or hulled) varieties, but natural inter-crossing takes place more readily between huskless oats and other oats as is shown by data published by Harrington in 1932. As a result of experiments at Saskatoon, Canada, he reported that the average amount of natural inter-crossing in hulled oats there was 0·07 per cent, with a range from nil to 0·20 per cent, and for the hull-less variety Liberty 3·68 per cent with a range from 0·51 per cent to 9·82 per cent. The " off-types " referred to above are examples of " throwing-back " and they arise as a result of natural inter-crossing having taken place in earlier generations between huskless oats and hard-husked varieties growing in the vicinity.

The general impression formed as a result of the trials at Corstorphine is that the varieties Liberty and Laurel are not well adapted to Scottish conditions and that on that account they are not likely to be extensively grown in Scotland. But although these varieties are not productive enough to be an economic success, it does not seem to follow that the possibility of breeding better types of huskless oats should be entirely ruled out. If a strain much better adapted to Scottish conditions and giving a better yield of grain could be secured, a valuable home-grown food would be available for poultry and pigs. Wheat is largely used for poultry feeding, but the price of this cereal has been rising considerably of late and doubtless huskless oats at an economic price would be a valuable substitute.

In view of the range of types of ordinary oats adapted to many different sets of conditions it would seem reasonable to assume that a somewhat similar range of types of huskless oats could be evolved. With this object in view the huskless oats Liberty and Laurel have been crossed at the Scottish Plant Breeding Station with various ordinary husked oats, and observations have been made on the progenies. Some of the varieties used as parents are Argentine, Beseler's Prolific, Elder and Bond. Several huskless selections from Liberty × Argentine, which are now in the sixth generation, appear to be fixed and are being multiplied for the first time this year. These selections had good-sized kernels, and they seemed to compare favourably with the huskless parent. The germination and tillering capacity of the selections also appeared to be satisfactory when they were grown as spaced plants. An estimate will be made of their grain-producing capacity, and if this is sufficiently high and is combined with other good qualities the best of the selections will be further multiplied on a field scale.

It is realised that a huskless oat must be able to compete on its merits with other oats on the market. To do so economically it must be adapted to the conditions under which other oats grow satisfactorily, and must also be able to produce about as much kernel per acre as they do. The kernels or seeds should be fairly large and should germinate vigorously in the soil. If the desired combination of characters can be obtained in a huskless oat, then the demand for such an oat at an economic figure could be met.

THE WINTERING OF EWE HOGGS

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ON Scottish hill farms, a certain proportion of ewe lambs (the exact proportion depending upon district and season) are kept back from sale to replenish the breeding stock. The best ewe lambs are kept for that purpose. The proper wintering of these stock ewe lambs or hoggs is a most important matter. It is all too easy to spoil ewe hoggs during their first winter, either by not doing them well enough or by doing them too well, and an error in management during wintering is reflected in the character of the ewe-stock for five years afterwards. It is possible, in a hill-stock, to recognise the effects of a particularly successful or a particularly unsuccessful wintering of ewe hoggs, years after the event occurred. It is no exaggeration to say that unless ewe hoggs are properly wintered, the parent stock from which they came can retain neither their character nor their size. Lowland wintering of ewe hoggs has become such a recognised custom of hill flockmasters that it is difficult to secure information regarding the reasons which led to this expensive practice being so universally adopted. The most important reasons as gathered from personal experience and conversation with flockmasters and shepherds may be arranged as follows, without attempting to dogmatise on their order of importance:—

1. The number of sheep a hill-grazing will carry is limited by the amount of grazing available on it during the winter and early spring months. If the carrying capacity of a hill-grazing is said to be twenty score, that means it will support 400 sheep throughout the year. It would, in all cases, carry far more during the summer months. Sending ewe hoggs to lowland wintering therefore allows more ewes to be kept on the hill. If the ewe hoggs were kept at home, either the ewe stock would have to be reduced, or the grazing would be over-stocked. If the ewe retained rears one good lamb she is well able to pay for the wintering of a ewe hogg. From this point of view the away-wintering of ewe hoggs actually costs nothing. The trouble arises where, as on some poor hill-grazings with low birth-rate and high death-rate, the annual value of the produce of a ewe does not cover the cost of wintering a ewe hogg. In such cases it actually costs money to winter ewe hoggs away from home. If there were no other advantages in the away-wintering of hoggs on such poor grazings, it would be sound economy to reduce the number of ewes and to winter the ewe hoggs on the hill. But there are certain definite advantages in wintering hoggs away. Thus—

2. The death-rate among away-wintered hoggs is much less than that of those wintered at home. Experiments conducted in Arran by the staff of the Rowett Institute in co-operation with flockmasters

showed this quite clearly. In the course of these experiments the progress of hoggs wintered at home without supplementary feeding was compared with that of hoggs wintered on lowland pasture. The death-rate among the home-wintered hoggs was much greater, as shown in the following table:—

TABLE I—YEAR 1929-30

	Number of hoggs	Number of deaths	Mortality per cent
Home-wintered	48	10	20·8
Away-wintered	75	4	5·0

In the following year the flockmasters were unwilling to risk so many hoggs by wintering them at home without supplementary feeding, and the numbers were reduced. The result was the same as in the previous year; mortality was much greater in the home-wintered hoggs.

TABLE II—YEAR 1930-31

	Number of hoggs	Number of deaths	Mortality per cent
Home-wintered	29	6	20·7
Away-wintered	66	4	6·0

3. Growth of home-wintered hoggs is less than that of those wintered away. The ewe hoggs on which experiments were performed in Arran were individually weighed at the beginning of October and again at the beginning of April. The results, expressed as percentage increase or decrease of the average live weight in October, show that ewe hoggs wintered at home without supplementary feeding lose a great deal of weight.

TABLE III

Percentage change in weight October to April

	1929-30	1930-31
Home-wintered . .	−22·5	−18·1
Away-wintered . .	−13·2	− 2·6

From Table III it is seen that while both home and away wintered hoggs showed a decrease in weight between October and April, this decrease was much greater in those home-wintered. So far as weight is concerned the fact that home-wintered hoggs may lose over 20 per cent of their October weight is of less significance since they put on all the more weight during summer and come to be but little lighter than hoggs wintered away. This is brought out in the following table:—

TABLE IV

Percentage change in weight

	October-April	April-July	October-July
Home-wintered	−22·5	+39·8	+ 8·6
Away-wintered	−13·2	+27·1	+11·8

Although body weight is the only practicable measurement which could be determined in the field conditions under which these experiments were performed, it does not really give a fair indication of the difference between home- and away-wintered hoggs. Although away-wintered hoggs in most cases actually lost weight during winter, they had nevertheless grown and matured. This was not true of home-wintered hoggs. The difference may perhaps best be explained in words written at the actual time of observation:—

"The away-wintered hoggs were obviously bigger, stronger, better-fleeced and showed a larger surface of new horn. They had a thriving and mature appearance. The most striking feature of the home-wintered hoggs was their immature appearance. They had rather the form of lambs than of hoggs, and had obviously been stunted not only in growth, but in development. The lamb-like heads on these sheep were remarkable. To put it shortly, the home-wintered sheep appeared several months younger than the away-wintered group."

Now, although the taking of actual weights showed that home-wintered hoggs, in the following summer, tend to overtake away-wintered hoggs where body weight is concerned, the conformation of home-wintered hoggs was less satisfactory. They tended to be lean and lanky, of narrow girth and thin bone, and they tended to retain that conformation throughout their life. Whether such defective conformation does or does not affect breeding power cannot be definitely stated, but it most certainly reduces the market value of cast ewes.

4. It is a common observation that one class of sheep does better when unmixed with other classes. That is perhaps particularly true when the difference between classes is one of age. Young sheep thrive better when removed from the competitive grazing of older sheep. Hoggs grow better when apart from ewes. That constitutes a further advantage in the away-wintering of hill ewe hoggs.

5. The question has often been raised whether a satisfactory alternative can be found to the lowland grazing for ewe hoggs. One possibility which the Rowett Institute has carefully explored is that by suitable supplementary feeding ewe hoggs might be made to live and grow as well on their native hills as they do when sent away. In view of the low mineral and protein content of most hill pastures, it seemed possible that some of the beneficial effects of lowland winter pasture might be got by feeding ewe hoggs a concentrate of high mineral and protein content on their native ground. This was first attempted in the Island of Arran. The plan of the experiments was to divide the ewe hoggs of each of several farms into three groups, one of which was sent away to lowland wintering; a second was kept on the hill without supplementary feeding; and the third was kept on the hill and fed a supplement of the following composition:—

	Parts by weight
Steamed bone flour	350
Ground limestone	150
Salt	150
Ferric oxide	50
Soya bean meal	200
Ground nut meal	250
Decorticated cottonseed meal	100
Linseed cake meal	70
Cod liver oil	100
Potassium iodide	0·251
	1420·251

The amount fed daily was 2 oz. per head. The experiment began in October 1930. The results as regards mortality are shown in the following table:—

TABLE V

	Number of hoggs	Number of deaths	Mortality per cent
Home-wintered	48	10	20·8
Home-wintered + suppl. feed	61	9	14·7
Away-wintered	75	4	5·0

It is at once apparent that while the supplement may have reduced mortality, the death-rate among ewe hoggs wintered away was considerably less than in either of the home-wintered groups.

In the year 1931, the experiment was repeated. The supplement fed was somewhat different from that fed in the previous year. Its composition was as follows:—

Steamed bone flour	74 lb.
Ground limestone	150 ,,
Salt	180 ,,
Soya bean meal	70 ,,
Decorticated cottonseed meal	70 ,,
Ground nut meal	70 ,,
Crushed oats	200 ,,
Cod liver oil	8 gallons

It was fed at the rate of 2 oz. per head per day.

The mortality results are shown in the following table:—

TABLE VI

	Number of hoggs	Number of deaths	Mortality per cent
Home-wintered	29	6	20·7
Home-wintered + suppl. feed	49	11	22·4
Away-wintered	66	4	6·0

Again it is clear that far more hoggs died, despite supplementary feeding, when wintered on the hill.

The results as regards growth were almost equally unfavourable.

They are summarised for the two years of the experiment in the following table:—

TABLE VII

Percentage decrease in weight between October and April

	1930	1931
Home-wintered . . .	22·5	20·7
Home-wintered + suppl. feed	18·0	22·4
Away-wintered . . .	13·2	6·0

It is clear that even when fed a supplement high in minerals and mixed proteins ewe hoggs wintered at home lose far more weight than those wintered away.

There are certain criticisms of the method of these experiments which tend to strengthen rather than invalidate the conclusions drawn. Both flockmasters and shepherds were inclined to play for safety by sending the weaker hoggs from the poorer hefts to lowland wintering, retaining the stronger hoggs from the better hefts at home. The initial advantage lay with the home-wintered hoggs, yet their progress during winter was a great deal worse.

Similar experiments on the wintering of hoggs were carried out on the Institute's own farm of Garrochoran in Argyllshire. There, the whole hill was fenced off into four areas or hefts, the sheep on each area being kept entirely separate from the others. In the year 1930 half the total number of ewe hoggs from all hefts were sent to Aberdeen and wintered on arable pasture only. The ewe hoggs kept at Garrochoran were fed along with the ewes, receiving supplements as follows:—

Heft 1—Maize—¼ lb. per head daily.
Heft 2—Mineral mixture—1½ oz. per head daily.
Heft 3—Maize + mineral mixture—¼ lb. maize + 1½ oz. mineral mixture per head daily.
Heft 4—Unfed.

The composition of the mineral mixture, based on the results of pasture analysis, was as follows:—

Steamed bone flour	3 parts
Ground limestone	2 ,,
Salt	1 ,,

From October to April the death-rate in the various groups of ewe hoggs was as follows:—

TABLE VIII

Heft	Number of hoggs wintered	Number of deaths
1	11	1
2	17	0
3	20	3
4	9	1
Away-wintered . .	55	3

The numbers of hoggs in individual hefts were too small to allow calculation of percentage death-rate. If, however, the death-rate of away-wintered hoggs is compared with those wintered at home, the respective percentage death-rates were—away-wintered, 5 per cent—home-wintered, 9 per cent.

The benefit of away-wintering on body weight was more striking. The percentage changes in body weight between October and April were as follows:—

TABLE IX

Heft 1	−22%
Heft 2	−23%
Heft 3	−19%
Heft 4	−32%
Away-wintered	+ 4%

More serious was the fact that the home-wintered hoggs, particularly those on Heft 4 which received no supplement, failed to recover lost ground during the following summer, as shown in the following table:—

TABLE X

Average weight in lb.

Heft	October 1930	April 1931	October 1931
1	49	38	65
2	53	40	68
3	50	40	70
4	50	34	60
Away-wintered	48	50	78

The general result of this experiment at Garrochoran was to suggest, very strongly, that a repetition of attempts to winter ewe hoggs on the hill was inadvisable, since there was an obvious danger of a rapid deterioration of the whole stock were the practice persisted in.

The main conclusions that can be drawn from the series of hogg wintering experiments both in Arran and at Garrochoran in Argyllshire are that the practice of away-wintering of ewe hoggs, whilst expensive, is yet necessary. When ewe hoggs are wintered on their native hill there is grave risk of excessive loss from disease, storm, accident and starvation. There is the further risk of permanent stunting or the development of undesirable conformation in the ewe hoggs that survive which, if repeated over a series of years, would lead to the general deterioration of the stock. Naturally, the poorer the hill, the greater the necessity for the lowland wintering of hoggs. On the better hills a certain number of well-grown hoggs can safely be retained at home, a custom not infrequently practised.

The results of the experiments performed prove that the feeding of a mineral supplement, or of protein and carbohydrate food in economic quantities, is not a satisfactory substitute for wintering on lowland pasture. The practical difficulties in supplementary feeding of hill sheep on the wilder grazings are, in any case, almost insuperable.

It seems certain, therefore, that the present method of wintering ewe hoggs by sending them away to winter grazing is the best. The same conclusion was probably reached by flockmasters after expensive experiments conducted by themselves. The cost of wintering is sufficiently high to encourage an eager search for efficient substitutes. Nevertheless it would seem that the cost of wintering is repaid, first by the fact that more ewes can be carried during winter because of the hoggs' absence, and secondly because the hoggs themselves live and grow better when wintered away. As a general custom the present methods of hogg-wintering are unlikely to be displaced.

There remain the exceptional cases of crofters in remote islands with perhaps only a few sheep, where the cost of wintering ewe hoggs may be prohibitive. In such cases the best line of approach would seem to be more intensive cultivation and manuring of the small amount of arable land available, so that the hoggs may be wintered, or partly wintered, on arable grassland without being sent away. An experiment on these lines is being conducted at Garrochoran this winter.

THE IMPROVEMENT OF GRAZING LANDS

GREAT prominence has recently been given to the possibility of effecting economic improvements on our grazing lands. The importance of this, so far as Scotland is concerned, can scarcely be overestimated. Out of a total area of nineteen million acres there are no fewer than twelve and three-quarters of rough grazing lands, including deer forests—actually two-thirds of the whole. In addition, there are some one and a half million acres, or nearly eight per cent, of land under permanent pasture exclusive of what is used for meadow hay. Within the limits of the combined areas it is only reasonable to suppose that there is much land capable of improvement. That such improvements are possible has been suggested by various articles in this JOURNAL and elsewhere.

The object of the present article is to state what has been done to bring about certain improvements on two types of land in the North of Scotland. The first type is the worn-out pasture, the second is unimproved moorland.

In the North of Scotland most of the permanent pasture cannot be described otherwise than as worn-out. It owes its present state very largely to neglect. In most instances the soil was poor to begin with, and the primary reason for putting such land down to grass was that it was unprofitable to continue to crop. Accordingly the land was laid down to grass, but in few instances were suitable grass seed mixtures employed. Then followed a gradual process of impoverishment. Lime and phosphates were continually being extracted by stock grazing the land, while manures were withheld in the belief that the money expended on them could not be recovered. Overstocking in winter and spring combined with understocking in summer had disastrous effects. Inferior plants like bent, Yorkshire fog and rushes gradually crowded out the better grasses and clovers. Surface applications of manures frequently gave little response. Even when surface cultivation was tried the results were generally disappointing. It was found exceedingly difficult to establish the desired types of plants in the face of the severe competition of the inferior types of grasses.

On such lands the only feasible means of improvement thought possible was to break up the land, put it through a course of cropping and reseed it down to pasture. In the post-war period of agricultural decline the returns obtained from the grain and root crops grown on such poor land were so small that they were altogether incommensurate with the expenses incurred. Moreover the sowing out of the grass seed with a grain crop did not always result in a satisfactory take of grass, and as is shown in the following account it was found better to aim at one thing only, viz., the establishment of a good pasture.

The following account of the work done at Inchindown, Alness, Ross-shire, is contributed by Mr Charles Allan, B.Sc.(Agr.), County Organiser for Ross-shire:—

Renovation of Pasture.—Inchindown, on the Newmore Estates of Mrs Robertson, is a grazing farm extending to some 170 acres arable with a heather hill outrun. The soil, for the most part, is a light stony brown loam with a peaty silt in parts. Until the renovation began about 10 years ago the pastures had been down for about 20 to 25 years, and were of very little value. The herbage consisted mainly of bent grass with rushes and fog in the wetter parts, giving a very poor pasturage. The sheep stock kept on the farm was a breeding flock of Blackface ewes with Blackface lambs. They had access to the hill ground, and the usual average summer stocking per acre, neglecting the hill land which was very poor, was 2½ ewes with lambs, plus one gimmer per two acres.

About ten years ago Mr Kenneth MacLean, farm manager on the Estates, conceived the idea of improving the pastures on Inchindown. Beginning on an experimental scale, he gradually increased the acreage treated each year as his methods met with success, until at the end of 1936, 70 to 80 acres had been renovated and converted from poor grazing to productive pasturage.

In the method of improvement that was found to be the most successful the rough land was ploughed in October or November with a wide furrow of 11 inches and up to 8 inches in depth, where that could be got. The furrow was turned entirely on its back and not set up on edge, as this latter method was apt to allow the grass to grow between the furrows, to interfere with the success of the subsequent cultivations, and to endanger the successful establishment of the young seeds. The laying of the furrow, Mr MacLean held, was a very important matter. The type of plough used was a " Sellars B.M.P." fitted with skimmers. For motive power, horses were used in the earlier renovations and for later work a tractor.

The manure mixtures applied varied according to the soil type. On the lighter stony loam parts, a mixture of ½ cwt. sulphate of ammonia, 2 cwt. superphosphate, 2 cwt. ground mineral phosphate and 1 cwt. potash salt 30 per cent was applied, and on the peaty-silt areas 5 cwt. slag with 4 cwt. kainit per acre. The manures were well harrowed in, 6 or 7 days before the grass seeds were sown. Mr MacLean maintained that proper harrowing was as essential as good ploughing, while cross-harrowing was unnecessary if a flexible harrow was employed. A heavy flexible harrow of the " Parmitter " type, drawn by four horses or a tractor, made an excellent seed-bed. On soft ground the tractor wheels might leave an uneven surface, but on drier land the tractor made excellent work. When four horses were used, yoked abreast, the trampling of their feet was most valuable in packing the fibrous turf. In harrowing great care was taken to see that pieces of turf were not taken to the surface.

Various grass seed mixtures have been tried at Inchindown, and Mr MacLean has now come to the conclusion that any properly balanced mixture of grass seeds will give a good pasturage, provided the preliminary cultivations are well done, the seed sown at the right time and the subsequent pasture properly managed. A mixture which gave a good pasture for sheep was 20 lb. Evergreen Kent Perennial Rye-grass: 3 lb. R.S. Meadow Grass: 2 lb. New Zealand Wild White Clover: 2 lb. Chicory: 2 lb. Hard Fescue: 2 lb. Giant Rape. In the sowing of rape it was found that 2 lb. per acre was ample, and that if a larger amount was included in the mixture, poorer results were obtained owing to the rapid-growing rape competing too keenly with the grasses.

In the earlier attempts at improvement the grass seed was sown out in April or early May with a nurse crop of oats. This method, however, gave disappointing results. In a year or two bent grass again formed most of the herbage. The idea of sowing directly on the upturned furrow without a nurse crop was then taken up and much more satisfactory results were obtained. It was found that the best time to sow was from 10th to 20th June. If sown earlier in May or June there was a very great danger of the young seedling plants dying for lack of moisture. Consequently there was often a very poor take of grass. If the grass seed was sown much later than the end of June, even given favourable conditions, the pasture would hardly be ready for grazing lambs at the end of August, and further the young plants would not stand the same chance of surviving winter frosts. When seed was sown about the time indicated it was found that there was generally sufficient moisture for germination, while the usual thundery showers in July assisted a subsequent even and rapid growth.

The grass seeds were harrowed in with the flexible harrows, and the land was then well rolled. It was found at Inchindown that where a firm seed-bed with a good tilth was formed, rolling before sowing was unnecessary.

It was also found that land thus sown in the middle of June was ready for sheep grazing about the last days of August. It was a mistake to leave the grass to become too long before it was grazed. When the growth of grass had been good it could be grazed with sheep in exactly the same way as first-class foggage. Mr MacLean assessed its value at about 10s. more per acre than ordinary foggage. There was no better lamb food, he maintained, than this kind of new grass. Winter grazing on this pasture is good, but it should also be properly managed, never overgrazed, and heed should be taken of Mr MacLean's maxim that "good shepherding and good grass management go hand in hand." In spring-time, the sole of grass is thicker and more mature than that grown under a nurse crop and the value of the grazing is fully equal to any other first year's grass.

Only a part of the pasture has been improved at Inchindown by the foregoing method, but already on account of the better grazing Mr MacLean is replacing the Blackface stock with Cheviots. This in itself is a clear indication of the degree of improvement achieved. Data as to the stocking of the field laid down in June 1934 indicated that by the end of May the following year each acre had provided between 150 and 160 sheep-weeks' grazing. It was expected that all the out-of-pocket expenses would be refunded by the end of the second summer.

So successful were the methods adopted at Inchindown that they were copied by various farmers as far away as Sutherland and Aberdeenshire. The following account of the work carried out by Mr Jack Rae, Cairnmuir, Memsie, Aberdeenshire, is contributed by Mr Alexander MacAulay, U.D.A., County Organiser for Aberdeenshire East, who was working in close conjunction with Mr Rae.

At this farm a fifteen-year-old pasture consisting largely of bent grass was ploughed up in February 1936. The plough used was one of the ordinary Sellar make fitted with a skim coulter. The furrow, 7 inches deep and 11 inches wide, was completely inverted for the reasons previously stated. On 25th April potassic mineral phosphate was broadcast at the rate of 10 cwt. per acre, and at seeding time, which took place on 6th June, 2 cwt. sulphate of ammonia and 2 cwt. muriate of potash were applied.

It was originally intended to defer sowing until about the end of June, but broken weather about the 6th of that month set in, and it was thought that a favourable opportunity had then come to sow the seed. The harrowing operations were carried out on the lines practised at Inchindown, but a certain amount of broken pieces of turf came to the surface. The seeds mixture used was a fairly typical one, except that it included long-lived and leafy strains of certain of the grasses. Five pounds of Italian Ryegrass as well at 2 lb. of rape and 1 of mustard were also included.

In spite of the long-continued spell of drought which lasted well into July and which affected adversely the establishment of the young seeds on the lighter parts the field was ready for grazing in less than six weeks, when a number of lambs were turned on. By 1st August the field was carrying 24 lambs per acre, and even then they could scarcely cope with the pasture, the rape plants in certain parts being left alone.

Exclusive of the cultivation the combined costs of seeds and manures amounted to a total of £4, 6s. per acre. Reckoning the value of the grazing at the very conservative figure of 3d. per sheep per week the returns amounted to almost half this amount by the end of November.

The experience of a single year's working on this farm tends to show that the ploughing should be done early and the furrows packed as solidly as possible. The subsequent cultural operations should aim at getting a good and level seed bed without disturbing the turf. Better results would probably have been got had the sowing been delayed until towards the end of June since there would have been more likelihood of rains coming in sufficient time to permit of all the newly germinated seeds establishing themselves. Sowing at this time would enable the pastures to be stocked by sheep in six or seven weeks, since this would be the time when lambs are weaned in the district.

Improvement of Heath Land.—It is significant of the progressiveness of the Orkney farmer that even in these days he continues to add to the area of arable land by breaking in land from the heath. Between 1929 and 1935 the area under crops and grass, as stated in the Annual Agricultural Returns, actually increased by over 1,000 acres.

Mr Gordon Watt, B.Sc.(Agr.), County Organiser for Orkney, has contributed the following account of the reclamation of twenty acres of a wet heathery moor which in its unimproved condition produced only a thin covering of heather plants along with some bent and Yorkshire fog. Its annual value might have been estimated at 2s. 6d. per acre.

Half the field was autumn ploughed in 1929 and the other half a year later. Special precautions were taken to see that the furrow was cleanly cut and completely inverted. The first ploughed portion was sown down to oats in 1930 and at the same time a dressing of 4½ cwt. of a manure suitable for a grain crop was applied. The harrowing was done in the direction of the furrow by spring-tooth harrows and rolling was carried out immediately afterwards so as to minimise the danger of drying out. This was considered by Mr Spence, the farmer, to be a very important factor toward the success of the crop.

This first portion was again ploughed in the following year and resown with oats. This time the ploughing was done in the same direction as the first ploughing, but about one inch deeper. The same manurial dressing was given. During the third winter the field was subsoiled prior to being prepared for turnips. Before the land was drilled for turnips 5 cwt. slag and 5 cwt. ground mineral phosphate were broadcast and harrowed in. This dressing was later supplemented by dung at the rate of 12 tons per acre and 2½ cwt. of a mixture consisting of sulphate of ammonia, superphosphate, steamed bone flour and muriate of potash. These manures were applied in the drill.

In the fourth year the land was laid down to oats along with grass seeds, while basic slag was applied at the rate of 5 cwt. per acre. One cwt. nitro-chalk was subsequently sown on the first year's grass. The grass seed mixture was as follows:—

12	lb.	Ayrshire Rye-grass.
6½	,,	Evergreen Rye-grass.
7	,,	Cocksfoot.
2	,,	Akaroa Cocksfoot.
3	,,	R.S. Meadow Grass.
½	,,	Crested Dogstail.
1	,,	Kent Wild White Clover.
½	,,	New Zealand Wild White Clover.
1½	,,	Mont. Late Flowering.
½	,,	Amer. Mamm. do.
½	,,	English do.
½	,,	English Broad-leaved.

Up to this stage the total manures applied per acre were as follows:—Sulphate of Ammonia, 2¼ cwt.; Nitro-Chalk, 1 cwt.; Superphosphate, 5¼ cwt.; Steamed Bone Flour, 2½ cwt.; Slag, 10 cwt.; Mineral Phosphate, 5 cwt.; Muriate of Potash, 1½ cwt.

This field was inspected in August 1936 when part of it was in second-year's and part in third-year's grass. The pasture was certainly one of the best seen that summer. On an average one and a half two-year-old bullocks were grazed per acre throughout the season. It should be noted that although the unimproved moorland showed by its vegetation signs of a lime deficiency no lime had been applied.[1] Seemingly the heavy dressings of slag and mineral phosphate had countered this deficiency, as red clover was growing well even as late as 1936. In other parts of Orkney it is customary in effecting the reclamation of moorland to allow the freshly-turned furrow to lie fallow for at least one year before any attempt is made to crop the land; see *Journal of Orkney Discussion Society*, Vol. XI, 1936.

General Results.—It would appear, therefore, that the breaking up either of worn-out pasture land or of certain types of moorland is at the present time a feasible and profitable proposition. It is noteworthy that the success of the work depends on the correct technique being adopted. A suitable seed-bed must be established, suitable seeds must be sown, the necessary manurial constituents must be incorporated with the soil and the pastures must be well managed. The most difficult part is undoubtedly the first—the establishment of a suitable seed-bed at an economical figure. Worn-out permanent pasture may be successfully resown on the upturned furrow should suitable measures be taken. It is noteworthy that at Inchindown progressive stages of improvement were noted year after year, the best year being 1936. The unreclaimed land in Orkney was put through a course of rotation before the grass seeds were sown. This in itself is a lengthy and expensive process. Some process involving far less expense should be aimed at even although it may involve an intermediate stage. This might be done by breaking it up, manuring it and putting it into as good a temporary lea as can be established under the circumstances in the hope that the wild white clover at least will give an account of itself. After three or four years of hard grazing this lea should be in a suitable physical condition for sowing down to a permanent pasture.

The fact that the work recorded here is being carried out indicates that farmers are not slow to adopt new methods, and that they realise the great possibilities of grass-land improvement. That the methods adopted are by no means perfect is evident to all who have studied the results and certainly the farmers themselves would be the last to assert this. What they want to know is how to improve their technique, how the desired seed-bed conditions can be achieved, what manures to use, what pasture plants and strains of pasture plants to employ and how to manage the pasture to the best advantage.

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[1] Moorland in Orkney does not always show a low pH value, but a dressing of shell sand is usually applied as a first step in any reclamation scheme.

RECLAMATION AND CULTIVATION OF PEAT LAND IN LEWIS—VI

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An account of the establishment and development of the Macaulay Farm on peat land at Arnish Moor in the Island of Lewis has been given in Parts I to V of this series of articles. Part V[1] dealt with the work done during 1933 and 1934, and the present article deals with the past two years.

The land from which the farm has been made consists of a peat moss of the *Scirpus* type varying in depth from a foot to fifteen feet or more. This type of peat land covers most of Lewis, and is found extensively in other parts of the country. In its natural condition it is particularly barren and provides very poor grazing for small numbers of sheep and cattle; arable cultivation in the past has been confined to small patches of shallow peat cultivated by crofters in an attempt to provide some winter keep for their stock which graze the moors. Until the Macaulay Farm was established, no experimental work had been carried out on this type of peat land, which differs in many respects from the peat land which has been reclaimed successfully on the Continent and elsewhere; in particular it presents very difficult drainage problems.

Two of the important practical aims which have been kept in view at the Macaulay Farm are:—

(1) The improvement, at as low a cost as possible, of the grazing on the moorland.
(2) The provision of additional arable land in order to provide more food for stock in winter, as without this the grazing land cannot be fully utilised.

Considerable progress along both these lines has been made at the farm during the past eight years. About 50 acres have been converted into arable land, and experiments on the improvement of grazing land have been conducted on much of the remaining 97 acres. The work, however, has been handicapped almost from the start through the lack of funds.

In January 1929 the farm was natural moorland, and from 1930 it has had to depend on the sale of produce for the greater part of the funds required for its maintenance and development. During that period, part of the arable land has been reclaimed, considerable areas have been improved as grazing land, farm roads made, and all the internal fencing erected. Part of the arable land has also been re-drained, since much of the initial draining was unsatisfactory; additions have been made to buildings and the stock has been greatly increased. Newly reclaimed land does not reach its full productive capacity for a number of years, but some of the first reclaimed land is now in good condition. The receipts have ranged from £424 in the year ending 31st March 1932 to £1,377 in the year ending 31st March 1936, and the total receipts for the period amount to £5,183.

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[1] *Scot. Jour. Agric.*, Vol. XVIII, p. 153 (Apr. 1935).

The whole project is an experiment, and valuable data have been obtained in many directions, especially on the establishment of good pasture on virgin moorland, but it is unfortunate that detailed experimental work and research have had to be curtailed. A stage has been reached, however, when more scientific work will have to be done, detailed data collected and fuller costings undertaken, if the best use is to be made of these preliminary results.

Policy during 1935-1937.—Owing to the circumstances outlined above (poor drainage, lack of internal fencing, and the fact that there were no farm roads which would support a tractor in wet weather) very little cultivation was done between 1932 and 1934, and at the end of 1934 practically all the fields which had been reclaimed were under grass. About 35 acres were under temporary grass, most of which was cut for hay, but much of it was deteriorating. Rushes and moss were becoming very prevalent, and it was desirable that some of the land should be cultivated and resown.

A new farm manager, Mr J. Black, was appointed in May 1934, and it was then decided to push on with road-making, draining and fencing, and to renew some of the pasture and grow more hay and silage. Without better roads it was almost impossible to bring in the crops, and the additional fencing was required to enable more of the land to be grazed by cattle and sheep. It was decided to keep sheep to graze the areas of improved pasture, and to eat down the grass on the fields near the steading at seasons when the peat was too soft for cows.

Draining, Road-making and Fencing.—In the autumn of 1934 a beginning was made with the re-draining of the wettest portions of the fields already cultivated. The collecting ditches were cleaned out and new secondary drains were cut to a depth of 4 feet. These were left open until the following summer, when they were cleaned out again, properly constructed wooden box drains laid and the trenches filled in. The unsatisfactory condition of the original drainage was chiefly due to the following causes:—(*a*) the drains were not deep enough, and after shrinkage, the boxes, in some places, were almost on the surface; (*b*) for this type of peat the trenches were not left open long enough before the boxes were laid; (*c*) the boxes were badly constructed and became displaced; the very heavy moorland cultivator probably did considerable damage to the drains. A few acres of very wet land which were re-drained in 1934-36 are now in a thoroughly satisfactory condition, and small areas are being re-drained every year.

A draining experiment, which was commenced in 1932 on a particularly wet portion of uncultivated moorland, is being continued. This area had numerous soft spots where water stood most of the year, and in which animals would sink out of sight in the deep slimy peat. Secondary drains were cut at different distances apart, and these have been left open and cleaned out every year. Owing to the highly colloidal nature of the peat, drying out of this area has been much slower than was expected, and even after three years a few of these " lochans " remained—in some cases not more than 2 feet from an open drain 4 feet deep. Marked shrinkage and lowering of the surface of the peat have taken place, and it is anticipated that it will be possible to lay boxes, fill in the drains, and cultivate the land in 1937.

An important practical conclusion has already been reached from this and other drainage experiments. It is undesirable to attempt to drain wet areas of this type of peat land in its natural state. Shallow sheep drains should first be cut, and a cheap pasture improvement scheme without cultivation (as described elsewhere in these articles) should be undertaken. The sole of grass removes some of the moisture by transpiration and promotes humification of the peat. This greatly facilitates a complete drainage scheme if the land is to be subsequently brought under cultivation.

A small area of peat road, which was made in 1932, has stood up well to traffic even in wet wether and, although this has involved a good deal of labour, roads have been constructed to all the fields. These still require improving, but it is now possible to bring in the crops from any part of the farm. During the past two years a considerable expenditure has also been incurred in fencing off the fields, but without this, proper use could not be made of the increasing amount of good pasture.

Cultivation and Manuring.—The initial cultivation of the farm was done by means of a moorland rotary cultivator (Lanz Fräse)[1]. This heavy machine did very good work where the surface was even and moderately firm, but it was not fitted with caterpillar wheels and under the conditions in Lewis it frequently became bogged. This difficulty and the fact that the machine, which was purchased second-hand, was in bad condition by 1934, made it imperative to try other methods of cultivation. It is probable, however, that a rotary cultivator, attached to a tractor of the caterpillar type, would be a very suitable cultivation implement for peat land.

In the autumn of 1934 some of the temporary grass was cultivated by means of the small rototiller and the rotary spade harrow, both of which have been previously described[2]. As in previous attempts with these implements, the results were not wholly satisfactory, since the cultivation was not deep enough, and did not bury the weeds. The rotary spade harrow, however, has been found to be useful in other directions, *e.g.*, harrowing after

[1] *Scot. Jour. Agric.*, Vol. XIII, p. 121 (Apr. 1930).

[2] *Scot. Jour. Agric.*, Vol. XV, p. 174 (Apr. 1932); Vol. XVIII, p. 153 (Apr. 1935).

ploughing and scratching the surface of moorland before sowing grass seeds.

In the autumn of 1935 cultivation was done by means of a German mouldboard moor plough with wide wheels[1], during the winter and spring about 20 acres were ploughed, including an acre of virgin moorland, and 2½ acres that had been cultivated with the moorland cultivator 5 years previously, but had never been cropped. The depth of ploughing was 9 to 12 in., and it was found that, with the shrinkage of the peat when partially dried and broken up, this depth was not more than was necessary. The deep ploughing had the beneficial effect of bringing raw peat to the surface, and exposure to the unusually severe frosts that winter, greatly facilitated the subsequent breaking down of the peat. The drainage conditions were also improved and the general result of this deep ploughing was very satisfactory, a fairly good crop being obtained even on the virgin peat.

After ploughing, the land was harrowed with the rotary spade harrow, and a satisfactory seed-bed was formed, but the harrow unit was too small and the cost of ploughing and harrowing was greater than would have been the cost of cultivation by means of a suitable rotary cultivator.

The area which was previously under cultivation had received manure from time to time, but it was feared that most of this might have been leached out. A laboratory examination showed, however, that this was not the case and only maintenance dressings were required. The amounts applied were varied according to requirements, but on an average 3 cwt. potassic mineral phosphate and 1 to 2 cwt. nitro-chalk per acre were applied. An area of 6 acres which had not been previously cropped received 12 tons per acre of farmyard manure as well as artificials.

Cropping.—About 14 acres were cropped with silage, oats and potatoes in 1935, the remainder of the arable land being under hay.

In 1936 the crops grown were 16 acres silage, 2 acres oats, 4 acres marrow-stem kale, 8 acres hay and 1½ acres potatoes and vegetables.

Silage and Oats.—The silage and oat crops were the best that have been grown on the farm; about 30 tons of silage was made and the remainder of the crop was fed green to stock. The silage mixture consisted of oats, tares, and Italian rye-grass, and the land was also sown out with a grass and clover seed mixture. Part of the area was being cropped for the first time and received shell sand and farmyard manure in addition to artificials. Even this newly reclaimed land produced a fairly good crop.

Conditions on the farm make the production of silage expensive as compared with costs on the mainland, but it is decidedly cheaper than imported feeding stuffs, and with better cultivation implements and improved roads and drainage the cost of production can be considerably reduced. Large quantities of hay, straw and other feeding stuffs are imported annually into the Island, and a comparatively cheap method of producing silage would go a long way towards solving the problem of winter keep.

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[1] *Ibid.*, Vol. XIV, p. 131 (Apr. 1931).

Hay.—The hay crop in 1936 was very disappointing, and the average yield did not amount to more than 12 to 15 cwt. per acre. This was attributed largely to an unusually dry spell in summer, for after the rain came the aftermath was particularly good.

Marrow-stem Kale.—An area of about 4 acres of land, part of which had been in grass for 2 years, and part never under crop, was ploughed, dunged and sown with marrow-stem kale in the spring of 1936. It was seeded (broadcast) at the rate of 6 lb. per acre, and also received a dressing of artificials. The crop made good progress at first, but the final result was disappointing. The average yield was about 5 or 6 tons per acre, but there were some good patches, and with better cultivation and an earlier application of farmyard manure it is anticipated that this crop will do well. It was interesting to note that part of the field which had been dunged in December was considerably better than the area dunged at the time of sowing.

Potatoes and Vegetables.—Both in 1935 and in 1936 small areas of potatoes (early and late) were grown, and except on one patch where drainage was inadequate, the results were satisfactory. Under the best soil conditions 8 tons per acre of Duke of York and British Queen were obtained and late varieties also gave good yields.

Among the vegetables, carrots gave a yield at the rate of 6 tons per acre and other vegetables such as cabbages, leeks, celery, onions and parsley did well. The small rototiller proved particularly useful in preparing the ground for the vegetables and in cleaning between the rows.

A ready sale was found in Stornoway for the vegetables and early potatoes.

Livestock.—The stock on the farm has been steadily increased and in the autumn of 1936 it consisted of 15 cows, 1 bull, 21 young cattle, 139 sheep, 4 pigs and 197 head of poultry. The introduction of sheep and pigs marks a new phase in the development of the farm.

Sheep.—The first sheep kept on the farm were purchased in the autumn of 1934. There were several losses through inadequate fencing, but there was a profit of £12, 10s. on the 71 sheep purchased. Larger stocks have been kept in 1935 and 1936, and these have done well and proved profitable.

With a view to improving the sheep stock in the Island a scheme for the breeding of rams for crofters was started in the autumn of 1936. A number of selected Lewis ewes and a Blackface ram from Skye were purchased. The ram is larger and of a better conformation than the Lewis type and the aim is to produce a better and more vigorous strain in Lewis, without losing either the desirable qualities of the Lewis wool or the hardiness of the Lewis sheep.

Cattle.—The dairy herd has continued to do well. The animals thrive on the farm and there is a good demand for T.T. milk in the Island. A good Ayrshire bull has been purchased, and a number of young stock have been kept. Twenty-one young heifers purchased last autumn got good feeding on the pasture until well into November. The grass was supplemented with cake and the animals have made very satisfactory progress.

Pasture Improvement.—A number of pasture improvement experiments are under observation.

No. 1.—The first of these was laid down in 1930 on a 2-acre plot of unbroken, undrained and rather shallow peat land[1]. One acre was treated with a compost made from pulverised peat, seaweed, herring offal, basic slag and a small quantity of farmyard manure, and was seeded with a mixture of grass and clover seeds. The second acre received the same treatment, except that nitrate of soda was added to the compost and herring offal omitted. The amounts of nitrogen and phosphoric acid were calculated to give the equivalent of 1 cwt. sulphate of ammonia and 4 cwt. slag per acre in each case, in addition to the farmyard manure, seaweed and peat used. The only cultivation was harrowing with an ordinary spike harrow.

No appreciable difference has been observed in the results from the two treatments. Germination was irregular owing to dry weather at the time of sowing, but by 1931 the heather, *Scirpus* and other native plants had begun to die. Early in 1932 shell sand was applied at the rate of 4 tons per acre and dung at the rate of 12 tons per acre, and the grasses and clovers made good progress. In 1934, 1 cwt. nitro-chalk, and in 1935, 1 cwt. nitro-chalk, 1 cwt. potash salts and 2 cwt. slag per acre were applied. A very good pasture has now been established and practically all the native vegetation has disappeared, its place having been taken by good grasses and clovers; wild white clover is particularly luxuriant.

A strip of each plot was left unseeded, but otherwise received the same treatment. In these strips there is very little wild white clover and most of the herbage consists of weeds.

No. 2.—Strips of rougher and more broken land were sown out in 1931 with cheap grass seed mixtures, and manured with a mixture consisting of fish refuse from a guano factory, superphosphate and potash salts. Where drainage conditions are fairly satisfactory, these plots have made very good progress. The grasses and clovers have become well established and the native vegetation is disappearing.

No. 3.—The question of cost was not the primary consideration in the experiments just described, but in 1931 an acre plot (known as Garst's acre) was laid down with a view to finding out the cost, in materials, of a moderate improvement in the native pasture. Shell sand was applied at the rate of 4 tons per acre and a manurial mixture consisting of 4 cwt. herring offal, 2½ cwt. superphosphate and 1 cwt. potash salts. The seeds mixture consisted of

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[1] *Scot. Jour. Agric.*, Vol. XV, p. 174 (Apr. 1932).

40 lb. ryegrass cleanings and 4 lb. wild white clover cleanings. The total cost was therefore as follows:—

	£	s.	d.
Liming	0	16	0
Manuring	1	5	3
Seeding	0	3	9
	£2	5	0

Improvement has been very gradual but steady, and the acre is now well covered with grasses and wild white clover. It has been grazed regularly and its grazing value is many times greater than the native moorland.

No. 4.—In the early spring of 1935 an area of about 2 acres near the south-west corner of the farm was dressed with dung. It had been drained several years previously with shallow open ditches 6 yards apart and the heather had become more prominent than on the adjoining undrained area.

It was intended to sow grass seed cleanings, but, before this was done, it was observed that there was a good germination of grasses and clovers. The dung had included sweepings of grass and clover seeds from the byre and without sowing grass seeds a good sole of grass has established itself. The heather is dying out and in the course of two years this area has developed into fairly good pasture. In the spring of 1936, this area was given a dressing of shell sand at the rate of 4 tons per acre.

An adjoining area received shell sand and dung in 1936 and in addition was sown with wild white clover cleanings. Rapid growth of the grasses and clovers is taking place.

No. 5.—An area of about 3 acres is being treated with artificial manures without dung. It has received shell sand and 4 cwt. potassic mineral phosphate per acre, and has been sown out with 1 cwt. ryegrass cleanings and 4 lb. wild white clover cleanings per acre. Seeding was done in August 1936 and a fairly regular germination has taken place.

These experiments indicate that the moorland of Lewis can be greatly improved as pasture at a low cost in manures and seeds. The humid climate makes germination and early growth possible on the damp surface without the necessity of cultivation. Shell sand, phosphates and grass seeds will give a marked response, but the addition of some potash and nitrogen provides better conditions for the growth of grasses and clovers, and these very soon overcome the slower growing native vegetation.

Review of the Possibilities of Peat Land Reclamation.—The work which has been carried out during the past eight years at the Macaulay Farm has shown that it is possible to reclaim successfully a very barren type of peat land which is widespread in Scotland. The best method of approach appears to be, first, the establishment of pasture, which has the effect of promoting humification of the peat and facilitating drainage. This renders subsequent cultivation and conversion to arable land easier if arable land is desired, but land of this type is particularly well suited for pasture. It has been shown that, on slopes where drainage does not present difficulties, the moorland can be converted into reasonably good pasture land at a cost (in materials) of between £2 and £2, 10s. per acre.

The production of arable land, involving under-draining and cultivation as well as liming and manuring, costs from £15 to £20 per acre, but a considerable part of this is cost of labour. In places such as Lewis, where crofters have spells when they are not busy, and where supplies of shell sand and seaweed are available, the conversion of small areas of moorland to arable land could with advantage be undertaken.

Acknowledgment is made of the valuable co-operation of the North of Scotland College of Agriculture, and of the services of Mr J. Black, Farm Manager.

Notes from Agricultural Colleges

Craibstone

Oats, 1936.—A slight snowstorm in February was followed by heavy rain at the end of the month and during the first part of March. This made the soil so wet that the sowing of oats could not be started until after the 20th, and it was into April before the sowing of the crop was generally completed. April and May were very dry and cool. The drought continued into June, and its bad effect was accentuated by cold winds and bright sunshine.

These circumstances had a detrimental effect on early varieties of oats, especially on light shallow soils, as they were too far advanced toward maturity to benefit from the heavy rain which fell in July. This rain, however, saved the later varieties and quite a good crop followed. This is illustrated by the yields obtained in the following trials which were carried out after potatoes on such a light soil (A) and also on a somewhat heavier soil (B).

A.	Order of Maturity	Yield per acre— GRAIN cwt.	STRAW cwt.
Monarch	1	18·2	29·2
Yielder	2	20·8	33·2
Early Miller	3	20·0	31·2
Star	4	27·6	35·0
G.892	5	27·4	34·5
Victory	6	30·9	37·0
G.895	7	28·3	35·4
Onward	8	27·3	36·2

In this trial the varieties may be arranged in two groups according to their maturity, the first three being from 10 to 14 days earlier than the others, while there was only a few days between those in each group.

While the yield both of grain and of straw was much less in the first group than in the second, there was a greater deficiency of grain than of straw.

Monarch is a markedly dwarf-growing variety and would require good deep soil for full development. The grain is medium in size and gives an attractive sample.

It is interesting to compare the yields of Yielder and Victory this year with, say, 1932, when there was sufficient moisture during the critical part of the growing season. In that year Yielder was fully better than Victory.

In the later group, Victory was distinctly superior to the other varieties, which were very similar in yield. Star, on the whole, since the seed was first treated with one of the mercuric compounds, has given a fully better yield than Victory, but this year, apparently, the season suited Victory better than Star.

Other three new varieties were included. G.892 showed a nice crop and gave a yield very similar to Star. The grain is very large but not rough. G.895 has a Tartarian ear; the grain is somewhat smaller than Victory but gives a nice sample. The crop, however, was slightly broken down before it was ready for cutting.

Onward, recently introduced by Messrs Garton, was slightly later than the others and was also somewhat broken down, possibly owing to the very heavy compact ear. The grain is similar in shape to, but larger than, that of Superb.

B.	Order of Maturity	Yield per acre— GRAIN cwt.	STRAW cwt.
McGS 24/28/18	1	32·6	40·8
Marvellous	2	23·4	30·6
Glasnevin Success	3	35·2	42·8
Star	4	33·3	41·3
Eagle	5	34·2	48·6
Victory	6	38·7	45·7
Elder	7	31·0	44·2
Resistance	8	31·3	38·2

In this trial a number of varieties were included which had been tried in recent years and given generally quite fair yields, but apparently were not so reliable as Star and Victory.

The effect of the heavier, slightly deeper soil is seen in the yields obtained from Star and Victory as compared with Trial A. Victory, however, is again distinctly superior to the other varieties except in straw, where Eagle was better. Marvellous, which is the second earliest variety in the list, gave by far the poorest yield. It may be stated that Marvellous has never given particularly good results in our trials in any year, although in some districts it is held in high repute.

A new variety, No. 24/28/18, from Messrs McGill & Smith, although earlier than Marvellous, gave a much better yield of both grain and straw, and looks as if it might be better suited for dry conditions than most of the other early varieties. The grain is large. An Irish variety—Glasnevin Success—was comparatively better than it was in 1934 and 1935.

Eagle has all along given consistently good results, but no doubt the yellow colour of the grain is against it as a general purpose oat. For feeding purposes, however, it has much to recommend it, especially as it usually gives a good proportion of straw and seems to suit medium-class soil.

Elder, although a late oat, has all along been unable to do its best under dry conditions, while Resistance, the winter oat from Cambridge which was tried for the first time last year, again gave a disappointing yield.

A trial was also carried out with a few varieties of the straw type of oats, and the following yields were obtained:—

	Order of Maturity	Yield per acre— GRAIN cwt.	STRAW cwt.
Pure Line . .	1	22·8	34·1
Utility . . .	2	19·6	32·9
Bell . . .	3	24·0	46·8
Sandy . . .	4	18·7	40·7
R.30 . . .	5	19·5	31·7
Castleton . .	6	23·6	34·0

The feature of the trial was the appearance of the growing crop of Bell, which was bred at the Scottish Plant Breeding Station and registered by the Department of Agriculture for Scotland. Although it was well over 4 feet in height it was all standing.

It looked distinctly better than all the other varieties in the trial, and, as will be seen from the weight of straw obtained, this was confirmed. The amount of grain, however, was only slightly greater than that of Castleton. The grain is about the same size and shape as Sandy, one of its parents, but it is much lighter in colour. Sandy was second best for straw, but gave the smallest yield of grain.

It would be worth while for those who grow Sandy to give Bell a trial.

The value of comparatively early seeding was again seen this year, as not only was the yield increased but there was a much greater chance of the grain being cut and secured before the rain at the beginning of September. The following result was obtained with Victory, which was sown on 29th March and 26th April:—

	Yield per acre— GRAIN cwt.	STRAW cwt.
29th March	27·2	43·9
26th April	19·5	42·4

While there was little difference in the amount of straw, there was a substantial decrease in grain when the seeding was delayed four weeks. In seasons when there is more rain in June the amount of straw from the late sowing is much less than from early sowing.

There is no doubt that many of the poor grain crops in the country are due to too late sowing.

The last few years have not been at all suitable for testing the value of varieties for standing power on our comparatively shallow soil. It was hoped to get some information regarding several new varieties, chiefly those from the Scottish Plant Breeding Station. The field had been in pasture for six years, and there was a thick covering of Wild White Clover. The dry weather in May and June apparently hindered the rotting of the turf, as at no time did the crop show that there was an excess of nitrogen. The results obtained were as follows:—

	Order of Maturity	Yield per acre— GRAIN cwt.	STRAW cwt.
S.S.P.B. 683	1	21·1	33·3
McGS. 24/18/7	2	26·0	46·0
Monarch	3	21·9	32·7
S.S.P.B. 667	4	18·2	28·4
Yielder	5	22·2	31·3
Early Miller	6	25·9	39·2
Pure Line	7	21·3	35·3
S.S.P.B. 676	8	23·0	41·7
Onward	9	29·2	38·7
Huskless	10	14·0	35·3
S.S.P.B. 657	11	34·3	42·8

Onward was the only variety that was slightly lodged, but it gave a good yield.

Among the earliest varieties tried, No. 24/18/7 from Messrs McGill & Smith was by far the most promising, with a high yield of grain and also of straw. The only one from the Plant Breeding Station that gave good results was No. 657, but it was much too late for late seasons. Their other new varieties were short in the straw and would require much deeper soil than ours to give them a chance.

The new Huskless Oat was included in this trial. It was seeded at the same rate as the other varieties, namely, 2¾ million seeds per acre. Even then it was far too thin, which possibly made it later in ripening than it might otherwise have been. There was also a considerable amount of second growth in August, which helped, however, to increase the amount of straw. In order to make the yield of grain comparable to other varieties, the amount of husk and kernel in several varieties was weighed. The proportion was 25 per cent of husk, so that, calculated on this basis, the yield of grain of the Huskless Oat would be 18·7 cwt. per acre. The kernel is very large and much more rectangular in shape than most kernels; 1,000 grains weighed 37·5 grammes compared with 30 grammes in the case of Victory.

Two or three years ago a Canadian variety, Laurel, was tried, but it also brairded far too thin and the yield was low.

Several trials have been carried out with shelled oats. In a trial this year 600 grains of shelled and 600 unshelled were sown. The shelled plot was very much thinner, only about 30 per cent having brairded as against 85 per cent of the unshelled. The plants from the shelled, however, tillered more and they were rather later in ripening. Owing to the greater tillering, the yield from the shelled was better than one would have expected but rather less than half that obtained from the unshelled.

	GRAIN	STRAW
Unshelled	17½ oz.	22½ oz.
Shelled	7¾ oz.	9¾ oz.

In previous years the advantage of treating seed oats with one of the mercuric compounds was amply demonstrated. A trial was carried out with Star this year with several different materials—Abavit, Agrosan, Ceresan and Leytosan—and all showed quite distinctly the benefit of the treatment, the untreated plots being much thinner and less vigorous.

There was practically no difference in the yields obtained from the different materials.

As in some previous trials, part of the seed was treated in January and part in March just before sowing. On each occasion half the recommended quantity of material was compared with the recommended quantity. The results obtained were as follows, and again indicate that when done sometime before sowing a smaller quantity of the mercuric compound would suffice.

		Yield per acre—	
Treated in—		GRAIN cwt.	STRAW cwt.
January	- Ordinary quantity .	29·0	32·4
,,	- Half ordinary quantity	30·2	32·3
March	- Ordinary quantity .	30·3	32·7
,,	- Half ordinary quantity	28·6	29·6
Untreated	. . . . . .	24·9	26·2

A trial was carried out in 1934 with Wild Oats. The plot was in potatoes in 1935 and sown out with barley in 1936. It is interesting to note that a fair number of plants of Wild Oats came up among the barley, indicating that the grains of the Wilds which had been shaken out in 1934 had kept fresh in the soil during two winters.

A number of samples of ordinary commercial oats were obtained this year and about one-third of them contained Wild Oats. It is understood that buyers in the south complain of the presence of Wilds. The number can be reduced by grading the sample thoroughly. A better way would be to get fresh seed without Wilds, but in this case care would need to be taken not to sow this fresh seed on land with Wilds.

Marrow-stem Kale

The following article is contributed by Messrs James Cochrane and John Macfarlan of the West of Scotland Agricultural College.

One of the crops which in recent years has been showing marked extension in acreage particularly in the dairying districts, but also elsewhere, is Marrow-stem Kale. The returns of the Ministry of Agriculture show that the acreage under Kales in England and Wales had increased in 1936 by over 14 per cent as compared with the previous year.

The Kale crop is an ideal supplement to pasture in the early autumn, and later its inclusion makes provision for succulence in the ration of dairy stock at a difficult period of the year. The method of feeding in general practice is to cut and carry the Marrow-stem Kale and spread it on the pasture where it is readily eaten by the stock. This method saves any trouble with the stems which are rather large for house feeding. If Marrow-stem Kale is to be fed to stock in the house, it is advisable to cut it before feeding, otherwise some waste is likely to result. A recent feeding trial with fattening cattle carried out by The West of Scotland Agricultural College has shown that Marrow-stem Kale on a dry matter basis was at least equal in feeding value to Swedes.[1]

As Marrow-stem Kale is a recent introduction to many districts and farms, there still are considerable differences in the cultural treatment adopted. One of the principal differences has been the width of singling, and, in order that some data might be available on this point, an experiment was carried out at Auchincruive in 1936. The crop was sown on 16th April at the rate of 4 lb. seed per acre in 27-inch drills. Previous preparatory treatment included the ploughing-in of 15 tons per acre of farmyard manure applied on the stubble in the autumn. Artificial manures were applied in the drill just prior to sowing, the manuring per acre being as follows:—

3	cwt.	Chilian Potash Nitrate,
2	,,	Superphosphate 16%,
3	,,	Ground Mineral Phosphate,
2	,,	Potash Salts 30%.

Owing to unfavourable conditions, germination and early growth was exceptionally slow and thinning was not carried out until 2nd June. After thinning, a top dressing of 1 cwt. per acre of nitrate of soda was given.

The experiment was devised to bring out differences (if any) due to singling at different widths. The spacings tested were as follows:—Plot 1, plants 6 in. apart; Plot 2, 9 in.; Plot 3, 12 in.; Plot 4, 15 in.; Plot 5, 18 in.; in Plot 6 the plants were left unthinned.

After thinning and the application of the top dressing, the crop made rapid and satisfactory growth and was ready for feeding from the middle of September onwards.

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[1] Paterson, W. G. R. *Trans. High. and Agric. Soc.* 1936. Vol. XLVIII, pp. 59 to 82.

The yields from the different treatments are given below, weighing and sampling being carried out on the 18th November.

Plot	Width of Thinning	Yield per Acre
1	6″ apart	26·9 tons
2	9″ apart	30·4 tons
3	12″ apart	29·6 tons
4	15″ apart	29·5 tons
5	18″ apart	23·7 tons
6	Unthinned	22·5 tons

From the above figures it would appear that the best width of thinning lies between 9″ and 15″, the yields from these three plots being approximately equal. Thinning at 6″ apart leaves the plants in a crowded condition, with the result that the maximum yield is not obtained. Singling at 18″, on the other hand, leaves insufficient plants per acre, and, while giving the heaviest individual plants, results in a lowered yield per acre.

The unthinned plot gave the poorest yield per acre, and the saving in the cost of singling was far more than counterbalanced by the increase in yield from the plots which were thinned; furthermore, while the crop in an unthinned condition may be a valuable one for folding sheep, it is unsuitable for cutting and carting, being more difficult to cut and load.

The Irradiation of Plants with Neon Light

Photosynthesis is the most important nutritional process of the plant and light is a primary factor in the process. Since, however, the rays emitted by the sun are not all similar, it becomes necessary to consider the different parts of the spectrum. The rays principally concerned with photosynthesis are contained in the red-yellow spectral region; these are absorbed by the chlorophyll of the leaves and enable the process of assimilation to proceed. If the light available for plants drops below a certain level, as it does during the short days of winter, growth practically ceases, even although all other conditions, such as adequate supplies of moisture and heat, are satisfactory. By augmenting the natural light with an auxiliary source of illumination, it has been found possible to obtain a continued growth of plants during the dormant season. A technique of irradiating plants in order to promote growth during this season has been evolved in Holland and a recent paper[1] by Roodenburg and Zecher on the irradiation of plants with neon light will interest horticulturists.

Photosynthesis is most active in red light. It has been found, however, that ordinary glow-lamps are not very satisfactory as auxiliary sources of red light, the reason being that such lamps give out an excess of infra-red rays which are not only superfluous but even deleterious, and which provoke "legginess" in plants. Neon light also contains infra-red radiation, but there is not the same disproportion between the infra-red and the red rays as is found with the glow-lamp. Neon light is, therefore, very suitable for promoting a normal type of growth in winter.

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[1] *Philip's Technical Review*, Vol. 1. No. 7. July 1936.

Experiments have shown that, as in irradiation treatment for medical purposes, the application of the correct dosage is important for success. The correct dosage is determined by the irradiation intensity and the time during which the plants are exposed to irradiation. Consideration must be given to the stage of growth of the plant and to the type of plant. In general, an irradiation period of eight hours nightly is recommended.

The equipment used consists of neon tubes, mounted in reflectors which increase the efficiency of irradiation. The plants to be treated may be placed at distances ranging from 20 inches to 5 feet from the neon tubes, the actual distance being determined by the type of tube used.

The paper discussed is illustrated with photographs of treated and untreated plants, and these leave no doubt in the reader's mind concerning the efficacy of neon light in accelerating growth during winter. The technical development of neon light sources for plant irradiation and the irradiation conditions laid down by Roodenburg will now permit commercial growers and amateur horticulturists to do much more in glass-houses in winter than has hitherto been possible. Unfortunately, no data regarding costs are available.

Fourth International Grasssland Congress

THE Fourth International Grassland Congress is to be held in July 1937, under the Presidency of Professor R. G. Stapledon, C.B.E., M.A., Director of the Welsh Plant Breeding Station and the Imperial Bureau for Herbage Plants, Aberystwyth, Wales. The previous Congresses in this series have been held in Europe, and membership was more or less confined to European members, but delegates will come to this Fourth Congress from Great Britain, the British Dominions and Colonies, U.S.A. and numerous other countries, members of the International Grassland Congress Association (Central Office in Leipzig, Germany).

The paper-reading sessions will be held in Aberystwyth from 13th to 19th July, but intending participants will be able to join in a tour of centres of grassland interest and selected farms both before and after these sessions. The first of these tours will be from Oxford to Aberystwyth, and the second from Aberystwyth to Edinburgh, where on 21st July members of the Congress will visit Boghall Farm and/or the Station of the Scottish Society for Research in Plant Breeding, Corstorphine.

All particulars may be had from the Joint Secretaries, Agricultural Buildings, Aberystwyth, to whom requests for the Preliminary Programme and application form for membership and all other correspondence regarding the Congress should be addessed.

Post-Graduate Agricultural Scholarships and Refresher Course Grants

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland invite applications (1) for agricultural scholarships from students who propose to follow the career of agricultural organizer or instructor or lecturer in agriculture (including horticulture, dairying, and poultry-husbandry), and (2) for grants for refresher courses from agricultural organizers, instructors, and lecturers already employed on the staffs of county agricultural educational authorities in England and Wales and from county organizers and instructresses on the staffs of the Agricultural Colleges in Scotland. The selection from candidates will be by interview, and the allocation of the scholarships and grants between the applicants from England Wales and Scotland will be made entirely on the basis of merit.

Agricultural Scholarships.—The object of the scholarships, of which not more than four will be awarded annually, is to broaden the agricultural knowledge and experience of students and so to qualify them for the position of agricultural organizer, instructor, or lecturer.

Candidates must be British born, and should be graduates of a University, but exceptional candidates, otherwise qualified, who have not had an opportunity of graduating, will be regarded as eligible. Application may also be made in respect of candidates who have sat for a Degree or Diploma examination of which the result has not been announced. In addition, candidates should have had some experience of practical farming.

The value of the scholarships will not exceed £200 together with an allowance for approved fees and travelling expenses. The amount may be varied in accordance with the scholar's means and may cover the whole of the cost of training, including maintenance, or a proportion only of such cost.

The period of the scholarships is normally one year and commences on 1st October. It will be spent at such agricultural educational or research institutions, advisory centres or farms as the Ministry or the Department may direct.

Candidates must be nominated by a Professor, Principal or Lecturer of a University or College on the prescribed form and the nomination must be received not later than 15th June. Students in England and Wales should submit their nominations to the Ministry of Agriculture and Fisheries and students in Scotland to the Department of Agriculture for Scotland.

Refresher Course Grants.—The purpose of the refresher course grants is to provide means and opportunity for those already engaged in agricultural educational work to widen their knowledge of particular branches of agriculture and to become acquainted with recent advances on the scientific side of the subject. Special courses will be arranged to suit the particular circumstances of successful applicants. Applications for grants for this purpose must be made on the prescribed form to the Ministry or the Department, and must be approved by the Authority or the governing body of the College by whom the applicant is employed and by whom the salary of the applicant would be payable during the period of the course.

The period of a course will normally be about four weeks, and in any instance will not exceed eight weeks, and will be spent at such agricultural educational or research institutions, advisory centres or farms as the Ministry or the Department may direct. Reasonable travelling and subsistence expenses and any fees incurred by a successful applicant in taking a course will be defrayed.

Forms of application for both the agricultural scholarships and the refresher course grants and all other particulars may be obtained, by English and Welsh students, from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1, and, by Scottish students, from the Secretary, Department of Agriculture for Scotland, 29 St. Andrew Square, Edinburgh, 2. The latest date for receiving applications is 15th June 1937.

Prize Essays in Agricultural Economics

THE Agricultural Economics Society has decided to offer two annual prizes of £10 and £5 respectively for essays on subjects connected with the economics of agriculture. Competitors must be either students at recognised institutions or holders (of not more than two years' standing) of degrees and/or diplomas in agriculture and/or economics. Essays for the current year must be sent in by the 31st March 1938, and must be on one of the following subjects:—

(*a*) Social and economic changes in the position of farm workers during the last twenty years.

(*b*) Sub-marginal land in Great Britain.

(*c*) The nature and extent of changes in farm organisation and technique since the War.

(*d*) The influence of a more adequate and well-balanced dietary for all classes upon the character of British Agricultural Output.

(*e*) Agricultural Tariffs and Quotas in Europe since 1924—Their Growth and Objects.

(*f*) Britain's security in time of war depends on home-production rather than on importation of .food supplies.

In the competition of the year 1935-36, the first prize was withheld and the second prize of £5 was awarded to Mr W. F. Searle, B.Sc.(Econ.), 10 Fladgate Road, Leytonstone, London, E.11, for an essay on "Trends of Production in Agriculture."

Reviews

Great Farmers. Prof. J. A. Scott Watson and May Elliot Hobbs. Selwyn & Blount, London, 1937. Price 12s. 6d.

If there still prevails anywhere in business minds or in urban opinion the notion that farmers as a class are unprogressive and restricted in their outlook, no better corrective to such an attitude of thought could be applied than a perusal of this fascinating story of the last hundred and fifty years of British farming. For without actually setting out to do so it presents a vivid picture of the farmer's life and work in its infinite variety and vicissitudes, which must impress the most prejudiced townsman with the multiplicity and the complexity of the problems which the farmer is called upon to face in his incessant fight with the forces of nature. Were we living under the rule of a dictator it would be no bad thing if an edict were to be issued that every urban householder should supply himself with a copy of this book to be carefully read and digested by old and young alike.

Nor indeed would this be any hardship; for the book treats of the most interesting matters, of attractive and outstanding personalities, and of events of the utmost economic importance. It is written in a manner so pleasant and in a style so simple and fluent that anyone with the least taste for country life will be reluctant to lay the volume aside before reaching the last page.

The book is, in effect, a history of the agricultural revolution in Britain, which, as Mr Walter Elliot reminds us in an appreciative foreword, was scarcely less important than the contemporary industrial revolution.

The first chapter is entitled "Marsh, Moor, and Fen," and it brings to our notice the almost incredible fact that even so late as the first half of the Nineteenth Century many parts of the country were still water-logged and unhealthy, breeding places for ague and malaria. So, draining is the beginning of the story, and we are told of the efforts and attainments of such leaders as Smith of Deanston, Graham of Netherby, Josiah Parkes and others. Their persistence led to the intervention and assistance of the State, which brought about a great amelioration in the condition of farm lands throughout both England and Scotland.

Attempts at reclamation of moorland are next described, notably those on Exmoor, where perhaps the main lesson learnt was how not to do it. The story of the draining of the Fens goes back to Elizabethan times onward, and the improvement was resisted by the stubborn fen-dwellers through several generations.

Numerous inventions of improved agricultural implements are noticed. Patrick Bell's patient determination to make a workable reaping-machine and his ultimate success are related with quite a dramatic touch, and although Bell's claim for priority is substantiated, Cyrus McCormick is given due credit for independent originality. Famous implement makers like John and James Howard, the Ransomes, Garrett of Leiston, Aveling and Porter, and John Fowler receive due meed of praise for the ingenuity they displayed in adapting machines to agricultural uses; and the coming of the tractor is noted as an epoch-making event in the methods of farming.

One of the most enlightening portions of the book is that dealing with the application of science to agriculture. The contributions of Liebig, Lawes and Gilbert, Middleton Somerville, Miss Ormerod, and many others are described. Plant-breeders like Patrick Shireff, John Garton, and Sir R. Biffen take their place in the procession of notabilities, and brief mention is made of the later developments of Agricultural Colleges and Research Institutes.

Examples are given of those who tried the new ideas and methods and stimulated the rank and file to follow their example. John Joseph Mechi of Tiptree, Essex, and George Hope of Fenton Barns, East Lothian, were men of this type, always ready to make known to others the results of their own trials.

One imagines that Professor Watson, who loves a good beast, would take a special pleasure in writing, along with his collaborator, the history of the improvements and modifications made in the breeds of farm live stock. Certainly the pictures presented of well-known stockmen are drawn with a highly appreciative and sometimes affectionate enthusiasm; and one is impressed by the intimate knowledge displayed alike of breed characteristics and of the men who studied and manipulated them. An admirably succinct account is given of the influence exerted upon British farming by three of the great Societies—the Royal, the Highland and Agricultural, and the Bath and West; and a tribute is paid to the valuable services rendered by the agricultural journals, as also by the more weighty publications of such writers as Caird, Rider Haggard, Lord Ernle, and Sir D. Hall.

On the trading side of farming the influence of great auctioneers like the Swans, William Elliot, John Fraser, John Thornton, and Alfred Mansell, has been quite definitely on the side of improvement in live stock, and their integrity of character is here proudly noted.

The general purpose of the book is stated as being to convey some notion of the immense contribution made by the past three generations of British farmers to the progress of farming. That purpose is brilliantly achieved. The book should take rank with Lord Ernle's "History," Sir Daniel Hall's "Pilgrimage," and other classics of British agriculture.

The illustrations are well chosen and beautifully reproduced.

A Survey of the Agricultural and Waste Lands of Wales. R. G. Stapledon. Pp. xv+143, with large map. London. Faber & Faber. 1936. Price 15s.

This book is unique in the outlook presented of land and the duty of the people towards it. Professor Stapledon puts forth not only what ought to be done to improve it, but also how it ought to be done. In this Survey he has enlisted the co-operation of a botanist, Mr William Davies, M.Sc., and a chemist, Professor

G. W. Robinson, M.A., each recognised as the authority in his own particular subject.

On the botanical side the Survey is (to quote the author's words) "an attempt to draw a picture of Welsh grasslands as they stand to-day," this being the first essential step in their improvement. It is remarkable in the detail which it gives of all the various types of vegetation within its compass, and covers the largest unit of area ever dealt with in such detail.

A study on such a scale is a feat in itself, but its true value to the community lies in the fact that it provides a "method of determining rapidly and with reasonable accuracy the practical possibilities" of that land.

The various types—botanical associations—are first described, their agricultural values assessed, and methods discussed by which each type could and should be improved. This is followed by charting the distribution of each type, county by county, culminating, as a climax to the whole survey, in a composite map which gives for the first time a complete picture of the whole of Wales from an agricultural point of view. This map, which is on the scale of 4 miles to the inch, is mounted on cloth and placed in a pocket at the end of the book.

The Soil Survey, from the very nature of its more elaborate technique, has had to be confined to a very much smaller area, but Professor Robinson has singled out for first attack those areas in the Principality which are of most immediate importance from the national point of view, and particularly so where the soil chemist can be of greatest assistance to the agriculturist.

This book should appeal to a very wide range of readers: to the student it is an ecological study, to the politician it gives a reliable picture of the present-day utilisation of the land, whilst to the farmer it gives the benefit conferred by modern grassland research.

The Apples of England. H. V. Taylor. London. Crosby, Lockwood & Son, Ltd. 1936. Price 21s.

The author has dealt with this subject in two sections. In Part I he deals with the conception of the term "variety" and shows how a variety is defined on pomological rather than on botanical grounds and is determined by a series of visible and external characters. These characters sometimes exhibit a considerable amount of variation in different districts and render more difficult the correct naming of some varieties.

The tree is considered as a colony of individual buds and the writer stresses the importance of variation or sporting (mutants) in specific buds or branches and the way in which many new varieties have arisen from this feature.

Mr Taylor deals at some length with the idea that most varieties have an allotted span of usefulness and that the almost inevitable degeneration of a variety is a well-known fact. He attributes this degeneration to the possible use of undesirable material in the continued vegetative propagation which does not allow of rejuvenation which might be possible in seed propagation. The degeneration is accompanied by, or even caused by, a gradual "susceptibility increase" to disease, but it is worthy of notice that he also points out that some of the oldest varieties have remained resistant to disease. This gradual "susceptibility increase" to disease he says accounts for the passing out of many varieties with which we were familiar in youthful days and possibly explains how the scab fungus has remained a scourge to the apple grower. The breakdown of Wellington, the reduced resistence of Bramley's Seedling to Scab and the extreme susceptibility of Warner's King to Canker are referred to and explained by this "susceptibility increase."

A chapter on the origin and history of some of the older varieties makes very interesting reading, and the descriptions of the activities of pomologists of bygone days is stimulating.

The necessity for more exact methods of identification is stressed. The fruit and the leaves which constitute practically the whole basis for classification are the two parts most likely to vary and the necessity for a more comprehensive basis of classification is clearly shown.

In a chapter which deals with the influence of chromosomes, an interesting and not too technical exposition is given. The sterility of certain varieties is explained by reference to the chromosome number. The chromosome make-up shows definite differences in self-fertile and self-sterile varieties and the importance to the breeder of a knowledge of these matters is shown.

The remarks on good and bad pollen parents are useful.

In Part II the history and pomological characteristics of some 600 varieties are given. The descriptive notes contain a considerable amount of information which is not usually given in a classification of varieties, and though it is less interesting than Part I it forms a very fitting completion to the subject.

The subject is treated throughout in a very pleasing manner and, like the good points of the author's subject, readily assimilable.

The book is very finely produced, with beautiful colour plates, and is appropriately bound in cloth of apple-green colour.

Sheep Farming. Allan Fraser, B.Sc., M.D., Deputy Director for Research, Duthie Experimental Stock Farm, Rowett Institute. London. Crosby, Lockwood & Son, Ltd. 1936. Price 7s. 6d.

In his foreword to this volume, Sir John Orr, Director of the Rowett Institute, refers to the fact that Dr Fraser has devoted many years to scientific research on sheep, that he has also had many years of practical experience, having herded sheep, managed them and sold them, while for six years he has been in charge of the sheep farm of the Institute and of the hill farm in Argyllshire, which also belongs to the Institute.

The work is not severely scientific, but is in many respects an eminently practical book, suitable for all engaged in sheep-farming. In it are shrewdly blended the results of personal experience and the wisdom and lore acquired from flockmasters and shepherds with whom he met, and the author seems to have been very fortunate in his contacts. Apart from this, however, Dr Fraser evidently possesses a discerning eye and a critical judgment, combined with a ready pen and a racy style of expression. As Sir John Orr aptly states, the book is written not only " from a profound knowledge, but with the enthusiasm that comes from a genuine love of sheep. It is written from the point of view of the field rather than the laboratory. It recalls the early dew on the grass and the bleat of lambs, rather than the smell of chemicals." It may with confidence be recommended to farmers, shepherds, students, and to the general reader, as a very readable book. Even on controversial matters, if the reader may not be disposed to agree regarding the methods and practices advocated, he will always find the treatment stimulating and thought-provoking, and therefore educational.

After briefly reviewing the present position of the sheep industry, Dr Fraser discusses some of our native breeds. Here he is evidently most at home with the Cheviot and Blackface, the crosses of these with the Border Leicester—Halfbred and Greyface—and the cross from these with Down breeds, so popular in the production of fattening lambs; but he is catholic in his tastes, and would grieve to see the passing of any old-established breed. "After all it is so much easier to destroy than to create, and the needs of the future are difficult to foresee." Thereafter he discusses such important questions as control of fertility, flushing ewes, selection, preparation and care of rams, and general management of the flock during the tupping season. No mention is made of the practice of clipping tails, which is so general in many hill districts, and on which Dr Fraser's views would be well worth having. His suggestions regarding treatment of newly purchased rams will be endorsed by all good sheep men. Many valuable hints are contained in the section dealing with wintering of the ewes, preparation for lambing, lambing and care of the young lambs. It is refreshing to find an author of such academic distinction endorsing the views held by many a good shepherd—" I believe the medicine chest to be the least valuable and most disheartening part of a shepherd's equipment . . . and I firmly believe I have saved more lambs by patience, warmth and whisky than by any other means." It may be somewhat overstating the position to aver that ready access to a fireside is worth at least a hundred pounds in a flock of twenty score of ewes, but no true sheep man will disagree with the contention that " warmth properly applied will save more lambs than all the medicines in the world " or that " the farm kitchen should be the first-aid station for the lambing flock."

Pastures, feeding, castration, shearing, buying and selling, dipping, diseases and their control, all come under careful review, and suggestive hints are incorporated that cannot fail to be helpful. At times the author's candour is somewhat startling. Thus, referring to the relation of mineral deficiency to abortion, he says " I particularly dislike mineralised salt licks. Salt licks without added minerals certainly—they should be before every pregnant ewe . . . but I dislike mixing other things with the salt, because the pregnant ewe in its craving for salt may soon eat too much of them. Iodine, for example, in anything but small doses is a poison;

rock phosphate may contain fluorine, another poison. Lime and phosphates in excess may cause abortion and malpresentation."

In other passages also the author's personal attitude is perhaps unduly stressed. It may also be remarked that the account of sheep diseases, necessarily brief in view of the size of the book, does not specify braxy, louping-ill or lamb dysentery.

The Internal Parasites and Parasitic Diseases of Sheep, their Treatment and Control. I. Clunies Ross and H. M'L. Gordon. Sydney and London. Angus & Robertson. 1936. Price £1, 5s.

Parasitic diseases are held to be the most important source of economic loss to the sheep industry in Australia, and the authors are to be congratulated on having succeeded in giving both the scientist and layman an indispensable reference work on sheep helminths.

The macroscopic and microscopic characteristics of a group or of individual parasites, which are of purely scientific interest, are first described. This is followed in the case of those parasites of major economic importance by a separate section containing a detailed description of their life-histories and methods of treatment and control. Of necessity problems of treatment and control are considered primarily from an Australian standpoint. Stress has been laid on the influence of climate and rainfall in the occurrence of the more important parasites in Australia, and as far as they are known, their distributions have been mapped.

The book is divided into three sections. Section I deals with the flukes and tapeworms; Section II describes the roundworms and Section III gives directions for the collection and preservation of parasites, and methods of diagnosis in the living animal. An appendix gives information of the relationship of parasites of rabbits and of kangaroos to parasitic infection in sheep. There is also a glossary of scientific terms and a bibliography.

The text is well illustrated by many original drawings. The book will prove of decided value to veterinarians and sheep farmers in this country.

A Practical Course in Agricultural Chemistry for senior students of Agriculture, Dairying, Horticulture, and Poultry Husbandry. Frank Knowles, F.I.C., and J. Elphin Watkin, B.Sc., Ph.D., Lecturers in Agricultural Chemistry in the East Anglian Institute of Agriculture, Chelmsford. Pp. viii + 188. London, Macmillan & Co., 1936. Price 10s.

The publication of this book supplies a want which has been experienced by teachers of practical agricultural chemistry for many years. While there are a number of manuals in existence at present, they have not been revised sufficiently to meet modern requirements, and the teacher has had no satisfactory book covering the whole course which he could place in the hands of his students, The aim of a practical course in agricultural chemistry is not to make the student an analyst but to give him such a knowledge of analytical methods that he will be able to appreciate and understand the significance of an analytical report when it is placed in his hands. This distinction is too often forgotten, particularly in courses in dairy chemistry, where the student (generally with an imperfect knowledge of chemistry) is burdened with all sorts of details of analytical methods for the detection of the adulteration of milk or butter, which properly belong to the work of the public analyst.

The authors have successfully avoided this difficulty, and, while the course covers the field thoroughly and the methods employed are accurate and rigid, there has been no tendency to stress too much the purely analytical side of the subject. The book is divided into seven sections:—I Soils; II Fertilisers and Manures; III Plant and Animal Bio-Chemistry; IV Feeding Stuffs; V Dairy Produce; VI The Chemical Examination of Water; VII Insecticides and Fungicides.

In each of these sections the treatment is adequate; the methods employed have been thoroughly revised and brought up to date and the analytical details are clearly set out. The student is assumed to have had an adequate training in theoretical chemistry and in laboratory methods of analysis.

The section on soils is very well done; the methods of sampling, and of determining the density and pore space, the " sticky point " and the mechanical analysis are carefully described. With regard to the " lime requirement " of soils the only method given is that of Hutchinson and McLennan; while this is about the only method available to students, its limitations might have been indicated. In describing the methods employed in determining the " available " potassium and phosphoric acid a few more details might have been given of the *Aspergillus niger* method which is now being largely employed.

The third section on plant and animal bio-chemistry is an exceedingly useful chapter in the book; the practical methods described are supplemented by a certain amount of theoretical detail which will be most helpful to the student.

In chapter IV the methods of food analysis are fully dealt with; there are useful details given of the mineral matter in feeding stuffs, the analysis of sugar beet and mangolds, and the examination of substances such as cod liver oil, and mineral mixtures used as additions to feeding stuffs.

Two of the most useful chapters, from the teacher's point of view, are those dealing with dairy products and with insecticides and fungicides. Fungicides and insecticides have not formerly been dealt with in any text-book, and the section dealing with the examination of these substances has proved most useful for students of horticulture in particular.

The book can be most cordially recommended. It is well illustrated and the printing and general get-up of the work is excellent.

Studies in Power Farming. I. Mechanised Corn-growing. A. Bridges and H. Whitby. *II. The Cost of Tractor Work.* J. R. Lee. Agricultural Economics Research Institute, Oxford. (Price 2s. 6d.).

A multitude of figures are available for the cost of mechanised corn-growing in the United States but, owing to the widely varying conditions, these figures are no guide to the cost of mechanised corn-growing in Britain.

The present report constitutes the first authoritative record of the distribution and costs of operation of all combine harvesters and their associated machinery in this country in 1934.

During an exhaustive survey of England and Scotland only 48 combine harvesters were traced in England and 3 in Scotland. Of the 48 in England 6 were not used in 1934; 4 were hired out by a Lincolnshire contractor; whilst the remaining 38 were found on 28 farms in the south and east of the country. Tractors were almost invariably associated with the combine, horse labour being comparatively unimportant. The combines were mainly used on light or sandy loams. Costs are dealt with in great detail. A representative figure for the initial cost of machinery is £3, 19s. per acre and on eight farms the total cost of harvesting, including drying and dressing, varied between 14s. 4d. and 29s. 3d. per acre, or 3s. 2d. and 6s. 6d. per quarter.

The second section of the report deals with tractor costs. The data used have been extracted from complete cost records, a fact which enhances the value of the figures quoted.

Operating costs varied between 2s. 8½d. and 3s. 9d. per hour. Interesting cost figures for the various tractor operations on the farm are worked out.

Labour economy is cited as one of the most important features associated with the use of tractors in the farming enterprise: the removal of the time limitation in agricultural work is also stressed.

Scientific Principles of Poultry Feeding. Bulletin No. 7 of the Ministry of Agriculture and Fisheries. H.M. Stationery Office, 120 George Street, Edinburgh (and other addresses). Price 1s. (postage extra).

The fourth, revised, enlarged and unquestionably improved edition of the above appears at an opportune time, when the prices of feeding stuffs are such as to give serious concern to the poultry keeper and to necessitate the examination of any possible means of reducing maintenance costs, without at the same time impairing efficiency.

The bulletin contains information that is of immense practical value and is based on the results of investigations carried out under the direction of the author, Mr E. T. Halnan, School of Agriculture, Cambridge, as well as by workers in other countries.

By way of introduction the essential constituents and functions of food and the anatomy of the digestive system of the fowl and its relation to diet are discussed, after which a statement is submitted as to the conclusions arrived at in connection with the question of the digestibility of feeding stuffs from a practical standpoint. Following on from this aspect of nutrition is a section dealing with dietetics, in which attention is directed to feeding from a qualitative standpoint, the effect of food on the quality of eggs and meat, the relation of feeding to the moult and the relation of minerals to growth and production.

Feeding standards in relation to production and the quantitative requirements for different purposes are considered, and useful tables are provided showing the daily requirements for growth and production of the three popular breeds—White Leghorns, White Wyandottes and Rhode Island Reds.

A further table shows the number of 2 oz. eggs provided for, in so far as protein and starch equivalents are concerned, in each lb. of the different feeding stuffs in general use.

Altogether the bulletin is a useful addition to the available literature relating to poultry and it will prove of value to all who wish guidance as to the practical application of scientific principles to the feeding of their birds.

Practical Animal Husbandry. Wm. C. Miller, M.R.C.V.S., F.R.S.E., and E. D. S. Robertson, M.R.C.V.S. Second Edition. Oliver & Boyd, Edinburgh. Price 15s.

The first edition of this most useful book was reviewed in this JOURNAL in April 1934. The second edition has been enlarged and revised and a section on the management of rabbits and fur-bearing animals has been added. It may be said that the whole field of animal management is covered, the management of horses being given in more detail than that of other animals.

The book should have a wide appeal, but will be particularly valuable to students of veterinary science and agriculture.

Tuberculosis (Attested Herds) Scheme

THE number of attested herds in Scotland at 28th February 1937 was 277, comprising 22,483 animals. The following table gives particulars of the herds attested in January and February.

Tuberculosis (Attested Herds) Scheme

Herds added to Register during the period 1st January to 28th February 1937

COUNTY	Name of Owner of Herd	Address of Premises on which Herd is kept	Date from which Certificate of Attestation is valid	Breed or Breeds of Cattle comprised in the Herd	No. of Animals in Herd at Date of Attestation
ABERDEEN	M. J. & M. Mackie	Westertown, Rothienorman	13th Dec. 1936	Friesian	144
	Elijah Mitchell	Leggat & Hillhead, Inverurie	31st Dec. ,,	Ayrshire	64
AYR	Gilbert Baird	Glenside, Auchinleck	5th Dec. ,,	,,	108
	John Boswell	Burnhead, Darvel	10th Dec. ,,	,,	31
	Walter Bowie	Muirhouse, Dreghorn	4th Feb. 1937	Mainly Ayrshire	40
	David Drummond	Jameston, Dalry	20th Nov. 1936	Ayrshire	93
	James Johnston	Knowehead, Sorn	28th Jan. 1937	,,	61
	Robert Lamont	Cockenzie, Dalry	8th Jan. ,,	,,	81
	Hugh Miller	Kittyshaw, Dalry	12th Jan. ,,	,,	16
	Thomas John Elliot Murdoch	West Tannacrieff, Fenwick	31st Jan. ,,	,,	61
	Mrs Mary Papple	Macnairston, Ayr	28th Nov. 1936	,,	79
	Trustees of the late David Stevenson	Muirdyke & Newfield, Cumnock	16th Dec. ,,	,,	32
	Mrs Mary Taylor	Langside, Galston	2nd Feb. 1937	,,	67
	John Templeton	South Blairkip, Mauchline	1st Jan. ,,	,,	76
	Miss Maggie Templeton	Henryston, Sorn	22nd Dec. 1936	,,	23
	Mrs Marion Wilson	West Heads, Newmilns	5th Nov. ,,	,,	101
	Alexander Young	Roughdyke, Mauchline	27th Jan. 1937.	,,	64
BUTE	William Craig	Meikle Grenach, Rothesay	27th Jan. ,,	,,	67
	Thomas Lochhead	Kildavanan & Scarrel, Rothesay	19th Oct. 1936	,,	99
	George Lyon	Drumachloy, Ettrick Bay	30th Oct. ,,	,,	85
	Peter Morrison M'Intyre	No. 1 Gortans, Rothesay	16th Feb. 1937	,,	5
	John Martin	Ardnahoe, Kingarth	9th Nov. 1936	,,	63
	John Martin	Scalpsie, Rothesay	10th Oct. ,,	,,	67
	James Montgomerie	Auchintirrie, Rothesay	10th Nov. ,,	,,	59
	John Morton	Kerrycroy, Rothesay	27th Nov. ,,	,,	58
	George Ross	No. 2 Gortans, Rothesay	2nd Feb. 1937	,,	27

Tuberculosis (*Attested Herds*) *Scheme*—contd.

COUNTY	Name of Owner of Herd	Address of Premises on which Herd is kept	Date from which Certificate of Attestation is valid	Breed or Breeds of Cattle comprised in the Herd	No. of Animals in Herd at Date of Attestation
DUMFRIES	John Brown	Templand Mains, Closeburn	10th Dec. 1936	Ayrshire	77
	Mrs Voilet T. Dickie	Knockenjig, Sanquhar	19th Jan. 1937	„	86
	Robert Graham	Blackford, Lockerbie	16th Jan. „	„	63
	David Paterson	Paddockhole, Lockerbie	22nd Sept. 1936	„	60
	James Stevenson	Muiryhill, Thornhill	18th Dec. „	„	78
	William Alex. Thomson	Dalpeddar, Sanquhar	31st Dec. „	„	84
DUNBARTON	George Main Miller	Duchlage, Cove	12th Jan. 1937	„	28
EAST LOTHIAN	Dr Douglas Chalmers Watson	Fenton Barns, Drem	23rd Jan. „	„	336
KIRKCUDBRIGHT	James and Hugh Gibson	Priestlands, by Dumfries	17th Jan. „	„	109
	John Weir	Midtown, New Abbey	13th Jan. „	„	106
LANARK	John Bannatyne	Drumalbin, Thankerton	16th Jan. „	„	91
	George Elder	West Yardhouse, Carnwath	31st Dec. 1936	„	63
	David Howie	Hillend, Crossford, Carluke	21st Jan. 1937	„	72
	Robert Lohoar	Holmhills & Greenlees, Cumbuslang	19th Jan. „	„	149
	Thomas Ballantyne M'Gregor	Lesserlinn, Lanark	15th Dec. 1936	„	99
	Thomas Pate, Jr.	South Draffan, Kirkmuirhill	15th Jan. 1937	„	104
	Robert and Thomas Scott	Eastertown, Sandilands	27th Jan. „	„	73
	John Simpson & Sons	Crofthead, Bishopbriggs	14th Jan. „	„	27
MIDLOTHIAN	University of Edinburgh (Institute of Animal Genetics)	Shothead, Balerno	9th Dec. 1936	„	105
PERTH	James John Neill	Rossie, Dunning	8th Jan. 1937	„	82
	George and John Cameron Paterson	Watson & Causewayend, Doune	21st Oct. 1936	„	68
	Sir James Denby Roberts, Bt.	Strathallan Castle, Auchterarder	25th Jan. 1937	„	22
RENFREW	Ardgowan Estates, Ltd., per T. D. Hamilton, F.S.I., Factor	Ardgowan & Bankfoot, Inverkip	15th Dec. 1936	„	92
	Robert Howie	Flatterton, Greenock	11th Feb. 1937	„	64
	John Telfer	High Branchal, Bridge of Weir	27th Jan. „	Mainly Friesian	94
	John Morton Whiteford	Nether Southbar, Inchinnan	13th Feb. „	„	69
STIRLING	Andrew Chalmers	North Kersebonny, Stirling	29th Oct. 1936	Ayrshire	46
	Mrs Catherine Buchanan Scott	Easter Balfunning, Drymen	16th Dec. „	„	49
WIGTOWN	J. & J. M'Intyre	Logan Mains, Port Logan	21st Jan. 1937	„	239

Unemployment in Agriculture

THE following figures of unemployment in agriculture and allied industries in Scotland have been supplied by the Ministry of Labour:—

INSURED AGRICULTURAL WORKERS, AGED 14-64, RECORDED AS UNEMPLOYED

(a) At 25th January 1937

INDUSTRY	MEN		BOYS		WOMEN		GIRLS		TOTAL
	21-64	18-20	16-17	Under 16	21-64	18-20	16-17	Under 16	
Farming, Forestry, etc.	2,631	368	290	175	289	69	82	44	3,948
Market Gardening, etc.	405	81	88	84	165	70	63	54	1,010
Other Gardening ...	387	18	8	5	19	1	2	8	448
TOTAL ...	3,423	467	386	264	473	140	147	106	5,406

(b) At 22nd February 1937

INDUSTRY	MEN		BOYS		WOMEN		GIRLS		TOTAL
	21-64	18-20	16-17	14-15	21-64	18-20	16-17	14-15	
Farming, Forestry, etc.	2,538	327	262	152	279	67	67	41	3,733
Market Gardening, etc.	406	88	85	75	150	66	65	34	969
Other Gardening ...	371	16	7	3	17	2	2	8	426
TOTAL ...	3,315	431	354	230	446	135	134	83	5,128

The following table shows the numbers of wholly unemployed men and women, aged 18 years and over, registered at Employment

Exchanges in Scotland at 7th December 1936, as applicants for work in agricultural occupations:—

	Men	Women	Total
Farm Worker	1,236	32	1,268
Farm Labourer	791	86	877
Poultryman	53	4	57
Fruit, etc., Picker ...	409	164	573
Forester	112	3	115
Forester's Labourer ...	76	1	77
Gardener, etc.	437	17	454
Gardener's Labourer ...	348	84	432
All Occupations	3,462	391	3,853

The following are the counties with the largest numbers:—Lanark, 834 (695 men, 139 women); Aberdeen, 414 (407 men, 7 women); Midlothian, 345 (257 men, 88 women); Angus, 286 (281 men, 5 women); Ayr, 282 (245 men, 37 women); Perth, 235 (218 men, 17 women).

Winter Census of Cattle, Sheep and Pigs

In order to obtain particulars of the changes in the distribution of the different classes of live stock throughout the country as between summer and winter, the Department again took a special census of the numbers of cattle, sheep and pigs on agricultural holdings in Scotland on 4th December 1936. The filling up of the forms was voluntary, and those concerned responded readily to the Department's request. Out of about 67,700 forms issued, over 52,500 or 77½ per cent were returned, covering 79 per cent of the cattle, 79 per cent of the sheep and 78 per cent of the pigs in Scotland at 4th June last, and were used as the basis of an estimate of the numbers of cattle, sheep and pigs in the country on 4th December 1936.

The results of the present inquiry and the comparable figures as at 4th June 1936 and 4th December 1935 are set out in the following table:—

[TABLE

Winter Census of Cattle, Sheep and Pigs

Description of Stock	Estimated Numbers on 4th Dec. 1936	Numbers‡ Returned on 4th June 1936	Estimated Numbers on 4th Dec. 1935	Increase (+) or Decrease (−) in December 1936: As compared with June 1936: Number	As compared with June 1936: Per Cent	As compared with December 1935: Number	As compared with December 1935: Per Cent
Bulls being used for Service	15,500	17,000	15,500	− 1,500	− 8·8	......	......
Cows in Milk	252,900	368,500	256,000	− 13,400	− 2·7	− 2,300	− 0·5
Cows in Calf but not in Milk	166,500	55,900	167,500				
Heifers in Calf (*i.e.*, with First Calf)	62,300	70,700	60,500				
Other Cattle, 2 years old and above	198,900	195,500	201,000	− 32,700	− 4·1	− 29,300	− 3·7
,, ,, 1 year and under two	300,200	331.500	315,500				
,, ,, under 1 year	259,600	273,900	272,000				
,, ,, Bulls and Bull Calves being reared for Service	9,500	*	9,000				
Total of Cattle	1,265,400	1,313,000	1,297,000	− 47,600	− 3·6	− 31,600	− 2·4
Ewes kept for Breeding	3,465,200	3,310,300	3,444,000	+ 154,900	+ 4·7	+ 21,200	+ 0·6
Rams to be used for Service	§116,300	96,700	101,000	+ 19,600	+ 20·3	+ 15,300	+ 15·1
Other Sheep over 1 year for Breeding	†252,900	704,900	186,000	−2,131,100	− 51·3	−158,700	− 7·3
,, ,, ,, ,, ,, Mutton		172,400	235,000				
,, ,, under 1 year old	1,766,400	3,273,100	1,757,000				
Total of Sheep	5,600,800	7,557,400	5,723,000	−1,956,600	− 25·9	−122,200	− 2·1
Sows kept for Breeding	29,300	28,900	30,800	+ 400	+ 1·4	− 1,500	− 4·9
Boars being used for Service	3,000	2,900	3,200	+ 100	+ 3·4	− 200	− 6·3
Other Pigs of all ages	224,900	204,600	238,000	+ 20,300	+ 9·9	− 13,100	− 5·5
Total of Pigs	257,200	236,400	272,000	+ 20,800	+ 8·8	− 14,800	− 5·4

‡ To nearest hundred

* Not separately distinguished; included in two preceding classes

§ Includes Ram Lambs

† Not separately distinguished

The total number of cattle in Scotland at 4th December 1936 is less than that in June 1936 by 3·6 per cent and below that at December 1935 by 2·4 per cent. Cows and heifers together are fewer by 2·7 and 0·5 per cent respectively. The numbers of cows in milk and in calf, between June and December 1936, show a marked seasonal change, while in December 1936, as compared with December 1935, there is no appreciable alteration. " Other cattle " show a decrease of 4·1 per cent compared with June 1936 and of 3·7 per cent compared with the previous December. Those of 2 years old and above are more numerous than in June 1936, while the younger classes show reductions. Compared with December 1935, all classes show decreases, except that for young bulls being reared for service, which shows a slight increase.

The total of all classes of sheep shows a decrease, compared with June 1936, of 25·9 per cent, and is less by 2·6 per cent than the total in December 1935. Ewes and rams show increases, while " other sheep " have been reduced in numbers by more than half as compared with June 1936 and are fewer by 7·3 per cent than in December 1935. The decrease between June and December 1936, which corresponds closely with that of the previous year, is mainly due to the sale of lambs for fattening and slaughter and to replacement of part of the breeding flock by younger sheep.

The total number of pigs shows an increase over the figure for June 1936 of 8·8 per cent, but a decrease of 5·4 per cent as compared with that for December 1935. In comparison with June 1936, sows, boars and " other pigs " of all ages are more numerous by 1·4 per cent, 3·4 per cent and 9·9 per cent respectively, but when compared with December 1935, these classes show reductions of 4·9 per cent, 6·3 per cent and 5·5 per cent respectively.

Agricultural Conditions

STRONG gales and heavy rainstorms were frequent throughout December, and weather conditions were generally mild and open. Rough weather held up farm work to some extent and the ground was too soft for progress to be made with the carting of manure, but on the whole the weather conditions were not unfavourable. Mild and open weather continued during January and severe gales were again frequent. Farm work made good progress until about the end of the month, when snow and heavy rains hindered ploughing and carting. In many districts the soil was at times too wet for cultivation, and in North Argyll a good deal of flooding occurred. During February the weather was generally cold, stormy and unsettled. The rainfall was considerably above the average, and yet in the Lothians the month was the sunniest February on record. Frost was frequent, and an exceptionally heavy snowstorm occurred at the end of the month. Work was very much hampered in most districts; the wet condition of the soil retarded ploughing, and carting was only done with difficulty.

The weather in December and January was generally favourable for the progress of the wheat crop and in most districts plants were looking fresh, healthy and strong. The crop generally continued to make good progress during February, although in Berwick wet conditions hindered progress and the crop had only a fair appearance. In Lower Moray the sowing of late wheat was held back by snow and rain, and in most areas spring sowings had not yet begun by the end of February. Estimates taken at the end of January indicate that there will be an increase in the area under the crop this year. In Berwick the area sown by the end of January was much greater than at the same time last year, but it was expected that spring sowings would be less. In Stirling the area sown under wheat was expected to be greater by about 75 per cent, and in some other wheat-growing districts increases were anticipated ranging from 5 to 15 per cent.

Last season's potato stocks, when taken from the pits, were generally in good condition and disease was not very prevalent. In South-West Angus, however, most varieties showed some disease, and on many farms about 25 per cent of the potatoes taken from the pits had to be discarded. In North-East Angus some varieties had lost condition and had gone soft in the pits, while others—*e.g.*, Majestic—had kept well. In Central Perth some varieties did not keep well. Golden Wonder potatoes in Dunbarton were lifted in splendid condition, but other varieties were more or less affected with blight and dressing of these was slow. In Ross there was a good deal of waste among some varieties.

Sheep generally made good progress during December and were healthy and free from seasonal diseases. Owing to rough and stormy weather, however, flocks lost some condition. In Dunbarton the tupping season for Blackface sheep was very unfavourable, while in North-East Fife, the Lothians and Peebles and North Ayr, sheep on turnip land became rather bedraggled and did not thrive too well. Open weather during the winter kept the grass fresh and green and favoured sheep generally, although towards the end of January rain and high winds retarded progress and ewes lost condition. Ewes and hoggets on grass throve very well, but conditions continued to be very dirty for sheep fed on turnips. In some districts by the end of January lambing had begun and in Lower Moray lambs were plentiful and strong, but a number of ewes died of toxaemia in February. The weather during this month was too wet and stormy for sheep and caused loss of condition. The fall of lambs was satisfactory and well up to the average, there being a good proportion of twins, but owing to inclement weather in some districts rather heavy losses occurred in lambing.

At the beginning of December roots were generally in good condition. In several districts, however, " Finger-and-toe " was prevalent, while some rot was showing among yellow turnips. In South-East Lanark and Dumfries raan disease was reported, while in Kirkcudbright and Wigtown the general condition of crops was very unsatisfactory, a large proportion being unsound. In a number of districts fodder was scarce, in others supplies were becoming rather short. In other districts, again, the open weather during the winter enabled stocks of fodder to be saved and supplies were expected to be ample. Hay and straw were scarce in South-East Perth, the Lothians and Dunbarton.

In some districts pastures had wintered well, but in most areas by the end of February they were looking bare and were not of much use for grazing. In several districts sugar-beet pulp is becoming more popular as a feeding-stuff.

Dairy workers were scarce during the winter in Dunbarton, Renfrew and North Ayr, and casual labour in Sutherland and Ross. In Mid Argyll, during February, owing to other work going on in the district, there was a shortage of capable farm workers, otherwise the supply of workers was reported to be ample.

SCIENCE AND PRACTICE

The following extracts and summaries are mainly supplied by members of the staffs of Scottish agricultural colleges and scientific institutions. Full references to the original publications are generally given; if further information is desired regarding these, application may be made to the Secretary, Department of Agriculture for Scotland, 29 St. Andrew Square, Edinburgh 2.

CROPS AND SEEDS

Observations relative to Pasture Seed Mixtures. *E. Bruce Levy. New Zealand Jour. of Agric., Vol. 53, No. 5.*· The real problem of the grassland farmer to-day and of the future is to learn first how to secure dominance of those pasture species that have proved themselves capable of high productivity when grazed by stock. Pasture-making is largely a question of harmonising plant and environment and of providing the environment that the high potential producer demands. The more closely plant-demand and environment harmonise the simpler can the seed-mixture be that is employed.

Care must be taken that an actual reduction in yield does not come about as a result of using the complex seed-mixture. The claim for complex seed-mixtures is sound however, when a complexity of soil types is dealt with. For the ploughable country, where the habitat and management can be governed at will, the case is strong for the simple seed-mixture composed of one or two grasses and one or two clovers. The intimate mixture of grass and of clover is imperative, and no effort should be spared to get the best possible strains and to secure the best possible conditions for the establishment of these. The perennial ryegrass-white-clover mixture demands controlled soil fertility, soil moisture and light and shade. The cocksfoot-red-clover-white-clover mixture demands an intensification of the shade factor, which means laxer utilisation.

Control of the environment must be the aim of every grassland farmer, and it is for him to learn how best to create a stable environment that will produce the maximum quality and quantity of edible herbage.

Breeding for Resistance to Late Blight in the Potato. *F. J. Stevenson, E. S. Shultz, C. F. Clark, W. P. Raleigh, Lillian C. Cash and Reiner Bonde. Amer. Potato Jour., Vol. XIII, No. 8.*—While control measures have been practised more generally than ever and spray equipment has been improved and spraying has been faithfully carried out, large losses continue to occur as a result of the attacks of this disease. Estimates show a reduction in yields in U.S.A., as a whole, of approximately 31 million bushels in the blight year of 1928, with an average for the 10-year period of 9½ million. It is claimed that the losses, although comparatively slight in some years, are large enough to justify increased efforts to eliminate the disease by still more efficient methods of control and by the production of blight resistant varieties.

It has long been known that varieties of cultivated potatoes show various degrees of susceptibility. The United States Department of Agriculture in co-operation with the Universities of Maine and Maryland are working to see what progress can be made with varieties and strains of *S. tuberosum* without the use of species hybrids. Various individual breeders, however, are obtaining encouraging results with certain species hybrids, particularly those in which *S. demissum* is a parent.

Selections resistant to late blight have been obtained by selfing a susceptible variety, by crossing two resistant varieties, by crossing a resistant variety with a susceptible one which was probably carrying two factors for resistance, both heterozygous, and by crossing two susceptible varieties.

Grass Studies. I—Influence of Constant Self-Pollination on the Development and Yield of Timothy. *S. Bezradecki. Pamietnik Panstwowego Instytutu Naukowego Gospodarstwa Wiejskiego W Pulawach, Tom 15, No.* 1.—Extracts from author's summary:—

On the basis of the experiments the author has come to the following conclusions:—

(1) Self-fertility in timothy is subject to significant deviations according to the genetical properties of the plant.

(2) Self-fertility in timothy is inherited, gradually falling off, however, in inbreeding from generation to generation.

(3) Inbreeding in timothy causes in the later generations, stunting of the plants, the appearance of albinos and the diminishing of the general yield of a plant.

(4) Inbreeding in timothy on account of its negative effect on the development of the plant is not practicable.

ANIMAL BREEDING

Aberdeen-Angus under Conditions in U.S.S.R. *I. A. Poljakov.* 1935. *Probl. Zivotn., No.* 3: 80-85.—In 1932, 12 young Aberdeen-Angus bulls and 8 heifers were imported from Britain to the Salsk Experiment Station. The animals are particularly remarkable for their resistance, there being not a single case of sickness during two years. The bulls yield sperm of good quality and perform mating readily. It is intended to utilise the milking capacity of the cows. The imported bulls have sired some 350 offspring out of Kalmuck cows. The weight of these calves was as follows:—(♀♀ given first), birth 23 kg., 3 months 87-89 kg., 6 months 137-135 kg., 1 year 210-238 kg. The relatively low weights are explained by primitive husbandry and poor nutrition. At the same time, these crossbreds are superior both to Shorthorn × Kalmuck crosses and to the best pure Kalmuck young; for example, at 1 year old, the bull calves weigh 50 kg. more, and the heifer 20 kg., an excess of 26% and 10% respectively. The incidence of mortality was 2·45%, while the Shorthorn crosses gave 5·2% and pure Kalmuck 10·04%. Mortality is restricted to the first 3 months of life and in the Angus crosses is distributed evenly over the 3 months, while in the other two groups 74-96% of deaths occur during the first month.

The Trek of the Golden Fleece. *R. H. Burns and E. L. Moody.* 1935. *Jour. Heredity*: *26*: 432-443 and 505-518.—This paper deals with the development of the Merino race of sheep and of all the breeds which have been evolved from the main stem. The origin of the Spanish Merino is a matter of controversy, but it is probable that sheep of a fine wool type were introduced to Spain by the Phœnicians hundreds of years before the Christian era, from Asia, Africa, Greece and Rome.

The various conquerors probably also introduced fresh blood, particularly the Romans and the Moors. The wool industry is a very ancient one in Spain, which flourished under the Roman occupation, 6 A.D. to 456 A.D. After the expulsion of the Moors about 1500 the Merino flocks passed under the control of the sovereign, but during the subsequent religious persecutions the sheep and wool industries were sorely neglected and eventually the flocks were sold to wealthy Nobles and Church Dignitaries, till ultimately they became more or less common property, with this characteristic that they had to travel far from one type of feeding to another during the year.

By the middle of the eighteenth century the other countries of Europe began to notice that sheep raising in Spain was the most profitable of the agricultural pursuits. Practically all the royalty of Europe lost no time in asking favours directly or indirectly from their Spanish relatives. These were not always granted, and in certain cases, such as the King of England, the animals were smuggled out of the country. It was at this time that the Merino was established in Germany, where it has been maintained in Saxony till the present time. Economic conditions no longer favour this wool type, and there are only a few flocks left. Merinos were also developed in Silesia and in Prussia. In the latter part of the nineteenth century a number of breeders in Northern Germany started to breed a combing wool type, and imported animals from the French flock at Rambouillet. It was these sheep, bred by Baron von Homeyer that started the boom for Rambouillet sheep in the United States.

In Austria the sheep were established under royal protection, and to-day the flocks of both Austria and Hungary are primarily Merino in character.

Louis XVI of France made many mistakes, but the sheep industry of the world has him to thank for one very wise act. In 1783 he purchased the Rambouillet Estate and established there an experimental farm for the acclimatization of animals and plants. He purchased some of the finest animals in Spain and established the flock.

The French were always much interested in mutton qualities, and from the first insisted upon this quality in the sheep at Rambouillet. There were a number of other flocks in France, but the term Rambouillet has now been applied to all French Merino sheep of the combing wool type regardless of their origin. The Mutton Merino is a somewhat different type.

It is in Australia that the development of this most ancient of the sheep breeds has reached it acme. The original importations were made about 1820. South Africa began importing in 1724, South America in 1794, and Russia in 1802.

The final section of this work is devoted to the Merino in the United States.

Mortality in Chick Embryos. *W. F. Dove.* 1935. *J. Agric. Res.*, 50: 923-931.—The writer examines the question of the position of the chick embryo in relation to the hatchability of the egg. He comes to the conclusion that the large portion of the embryos that fail to hatch are in positions which can be considered as the secondary effect of some more fundamental defect. He believes that the fundamental causes of the defective condition in an embryo, whether they be from effects of inbreeding, faulty nutrition, or of careless incubation methods, will interfere with the normal sequence of body shiftings, with the result that the embryo, when it dies, will be in a strained position.

The Position of the Chick at Hatching. *J. R. Cavers and F. B. Hutt.* 1934. *J. Agric. Res.*, *48*: 517-531.—The position of the chick embryo in the shell was determined by candling four days after incubation had begun. The apparatus contained two 500 watt lamps with an electric fan to cool them, and the egg was placed in a hole at the top of a box. Eggs of White Leghorn fowls were used, since their chalk-white shells transmitted the light readily. Some 4,700 embryos were examined at this early age. It was found that 75 per cent of these embryonic chicks lay within 45° right or left of a line at right angles to the long axis of the egg, and that their heads were to the left when the small end of the egg was directed away from the observer. Eggs in which the chicks were found in the standard position at four days hatched out much better than the eggs in which the embryo chicks were in other positions. However, the abnormal arrangement of the young chick embryo had no adverse effect until the last four days of incubation.

One mal-position on the fully formed embryo, that in which the body is upside down with the head in the small end of the egg, occurred five times more frequently among embryos which had been thus oriented as early as the fourth day of incubation. The writers suggest that the normal orientation of the chick embryo has been evolved and established by virtue of the greater survival value which it confers upon the developing chick.

Inbreeding in the White Leghorn. *N. F. Waters and W. V. Lambert.* 1936. *Iowa Agric. Exp. Stn. Res. Bull. No.* 202.—Of recent years a considerable amount of work has been done on the subject of inbreeding. Till recently no very systematic attempts have been made to use close inbreeding in a practical way for family improvements. Many breeders have recognised the usefulness of the method as a means for fixing traits, but have avoided continued close inbreeding for fear of also fixing undesirable characteristics. However, progress has been made with inbreeding in the field of plant improvement with remarkable success as regards productive characters. With smaller mammals intensive inbreeding has been carried on, but relatively few experiments have been conducted with the farm animals.

Continued close inbreeding in the fowl almost invariably has resulted in disaster. Hitherto no experiment has been reported in which very close inbreeding has proceeded beyond the sixth generation. The whole subject of inbreeding and cross-breeding in poultry is reviewed by the authors.

For the experiment the foundation birds were obtained from the flock of the Iowa State College. The object of the experiment was to discover the effect of inbreeding in the single comb White Leghorn fowl as regards fertility, hatchability, viability, days to first egg, egg production, egg size, and body size. It was also intended to develop lines homozygous for a number of the characters of greatest economic usefulness.

The degree of inbreeding adopted was somewhat less intense than that of brother and sister or parent and offspring matings. However, one intensely inbred family was maintained successfully for nine generations, while six more or less distinct families, each with a different type, but with similar foundation ancestry, were developed.

The ancestry of all the birds in these six families is traced to four males and seven females. One of the original males has a greater degree of relationship to the present generation than any of the other foundation birds.

There was no general decrease in per cent of fertile eggs as the degree of inbreeding increased. On the contrary, some inbred families showed an increase of fertile eggs. There was a decline in the average hatchability of fertile eggs as inbreeding increased: as the hatchability was well above 60 per cent this is not considered a serious matter. The authors conclude that it is possible to maintain a reasonably safe level of hatchability under a system of intense inbreeding. There was a significant decrease in the number of days to first egg. The most intensely inbred birds mature sexually sixteen days earlier than the birds of the original non-inbred foundation stock.

There was no marked decrease in the 200-day egg production for any of the six separate families, neither was there any decrease in egg weight. Growth rate and adult body weight were unaffected. Pullet year mortality, however, showed a marked rise for the more intensely inbred birds. One point of special interest was the freedom of defects and abnormality of all types.

The authors hope that the favourable results will encourage other investigators to undertake the development of good inbreds, and the present study suggests a practical application of the principle of inbreeding. How much should a poultry breeder inbreed without decreasing the efficiency of his flock? In general, the advanced breeder desires to confine his breeding programme to his own flock, thus reducing the dangers involved when unrelated birds are introduced. Inbreeding tends to increase uniformity within the flock, not only for type and general conformation, but for all other characters, both good and bad. The inbreeding provides a mechanism by which the good results of right crosses and the bad results of wrong choices in selection are much more apt to be retained in the flock and fixed permanently on it than if no inbreeding accompanied the selection; therefore, the breeder who is inbreeding must be exceptionally cautious in his choice of birds for breeding if he is to avoid the fixation of undesirable characteristics in his flock.

DAIRYING

Cleaning (Dairy) Equipment. *Rogers and Evans* (1936). *J. Dairy Science, 19,* 733.—Cream separators, milking machines, and dairy utensils even when made physically clean may harbour considerable numbers of bacteria. Alkaline washing powders not only assist in rendering vessels physically clean, but in appropriate concentration and at selected temperatures have a definitely bactericidal effect. Trisodium phosphate is to be preferred, because it is not only an excellent detergent, but also because it has a less corrosive effect than other alkalis. Even the small corrosive effect it induces may be reduced to almost negligible amounts by the addition of a small proportion of sodium chromate. In making up the detergent use 5 per cent trisodium phosphate (containing 3 parts per 100 of sodium chromate). The detergent has no effect on the rubber tubing of milking machines. After milking is completed, the rubber tubes and their connections should be irrigated with clean water and then submerged in the sodium phosphate-chromate solution between the milkings. Before the next milking, rinse with boiled water to remove traces of the cleaning solution, and then draw one half gallon of sterile water through each unit. Change the solution weekly.

This detergent is well adapted for the treatment of homogenisers.

Emery Flavour in Milk. *Mohr* (1936). *Molkerei Ztg., 50,* 1454.—This flavour defect is intensified by the presence in the milk of small amounts of copper derived from the equipment. Stainless steel does not contribute to this off flavour. The special substance responsible for the undesirable flavour exists in the fat phase in milk and is largely carried over to the cream and butter made from it.

Churn Cleaning Methods. *Bendixen* (1937). *J. Dairy Science, 20,* 15.—The author studied the relationship between the methods adopted in butter factories (participating in butter scoring contests) and the keeping quality of butter. He observes that a satisfactory method of churn cleaning involves the use of an ample amount of hot water at a temperature of 180° to 200° F, and keeping the hot water (which should be equal in volume to one-half the churn capacity) in contact with the revolving churn for at least half an hour. The addition of 0·1 to 0·2 per cent washing powder to the water assists in removing the grease, increases the germicidal effect, and improves the odour of the churn. In addition to the hot water treatment, a rinse with a chlorine preparation supplying 50 parts per million chlorine to the water gives good results.

SOILS

Response of Plants to Boron, Copper and Manganese. *Muckerhirn. Jour. Amer. Soc. Agron.* 28, 10, 1936.—The literature on the role of these "minor" elements in plant growth is reviewed. A description is given of a series of experiments on the effects of boron on the growth of lettuce in sand cultures and on the effects of copper, manganese and zinc on onions and sweet clover in pot cultures with peat. Results obtained on a peat soil in a series of field experiments with onions and potatoes are also discussed. The addition of small dressings of the various elements was found to effect marked increases in growth.

The Influence of Organic Matter on Nitrate Accumulation and the Base Exchange Capacity of Dickinson Fine Sandy Loam. *Miller, Smith and Brown. Jour. Amer. Soc. Agron.* 28, 10, 1936.—Experiments indicate that the accumulation of nitrates in the soil was significantly correlated with the nitrogen content of the plant material added. Leguminous materials generally increased the adsorption capacity of the soil more than non-leguminous materials.

Influence of Soil Management on Some Physical Properties of a Soil. *Stauffer. Jour. Amer. Soc. Agron.* 28, 11, 1936.—Poor systems of cropping and soil treatment are shown to be accompanied not only by rapid declines in crop yield and a decrease in the plant food content of the soil, but also by undesirable changes in the physical condition of the soil.

The Rate of Decomposition of Various Plant Materials in Soils. *Miller, Smith and Brown. Jour. Amer. Soc. Agron.* 28, 11, 1936.—Plant materials low in nitrogen decompose more rapidly than materials rich in nitrogen, although in the first few days, when the plants are beginning to decompose, decomposition is more rapid with plant materials rich in nitrogen.

On the Influence of Wart Disease on the Metabolic Processes involving Magnesium in the Potato Tuber. *Nemec. Die Ernährung der Pflanze.* 32, 24, 1936. Potatoes affected by wart disease were found to contain less potash and magnesia than healthy tubers. The ash of infected tubers was much lower in magnesia than was the ash of healthy potatoes.

The Fertilizer Value of some Concentrated Materials, particularly Urea and Guanidine and their Nitrates and Phosphates. *A. H. Lewis. Jour. Agric. Sci.* 26, 4, 1936.—Urea salts appear to be particularly suitable for use on neutral soils where quick action is required, whilst guanidine may be used as a slow acting form of nitrogen. Phospham and phosphorus nitride have very little manurial value.

Different Kinds of Barley and Oats in Five Years' Experiments on Sphagnum Peat Soil at Flahult (Sweden). *G. Rappe. Svenska Mosskultur. Tidskrift.* 50, 6, 1936.—It was found that barley could be grown successfully for fodder production in regions where rain and sunshine are evenly distributed throughout the growing period. Recommended varieties for barley are Gull and Drake and for oats Golden Rain II and Bambu.

The Base Status of Scottish Soils. I—The Effects of Lime on Five Typical Soils from North-East Scotland. *R. L. Mitchell. Jour. Agric. Sci.* 26, 4, 1936.—The field response to liming as shown by the decrease in soil acidity and change in base status is dependant on the soil type, which in turn in the area under consideration depends largely on the geological parent material. The soils on basic ingenous drift appear to utilise the lime more efficiently than those on acidic rock types.

A Green Manure Fertilizer Study on Norfolk Sand. *Adams, Roller and Boggs. Soil Sci.* 42, 3, 1936.—A comparison has been made of legumes stubble with the full crops of the legumes turned as green manures when used in a rotation with corn and cotton at the S. Carolina Branch Experiment Station. Yields were influenced more by the nitrogen of the fertilizer than by the management of the legumes. The winter cover was apparently more effective in influencing yields than was the legume green manure or legum stubble.

Manganese in New Jersey Soils. *Blair and Prince, Soil Sci.* 42, 5, 1936.—The content of manganese is higher in soils from the northern part of the state than in those from the southern. It is suggested that with heavy liming the maganese is rendered less available. The lowered intake of manganese by the plant does not appear to have an ill effect on yield.

The Weed Seed Population of Arable Soil. III—The Re-establishment of Weed Species after Reduction by Fallowing. *Brenchley and Warington. Jour. Ecology.* 24, 2, 1936.—A continuous quantitative experiment has been carried out since 1925 by these authors on Broadbalk wheat field at Rothamsted in which the potential weed flora has been estimated and the effect of fallowing and cultivation among the crop on the (numbers of) weeds. Delay in cultivation after harvest prevents the reduction of various weeds by fallowing. After fallowing, the first wheat crop tends to be abnormally heavy and increased competition occurs with the weeds. Species which soon begin to re-assert themselves tend to increase rapidly in number, and after three years under crop they may be much more plentiful than they were before fallowing began. Prolonged fallowing for four years reduces the store of buried weed seeds drastically, but does not eliminate all. The period of natural dominancy of most species on Broadbalk proved to range from four to nine years.

Fertilizer Experiments with Oats covering a Period of Two Years. *Pawlik. Superphosphate.* 9, 10, 1936.—Results of trials at the Agricultural Collere, Goldbrunnhof, Carinthia, are given for the years 1933 and 1934 where a comparison was made of stable manure worked into the soil; and applied as a top dressing; a combined application of superphosphate and potash salt; and Nitrophoska and liquid manure mixed with superphosphate.

Influence of the Types of Rocks on the Plant Food Content of Natural Soils. *35th Report of the Soil Division of the Central Agricultural Experimental Station, Finland. c.f. Superphosphate.* 9, 10, 1936.—An account is given of experiments to determine the influence of rocks on the properties of the types of soils in general and on the nutritive composition of the organic layer in particular.

Boron-Superphosphate as a Means of Combating Crown and Dry Rot in Beet Root. *Wiener Landwirtschaftliche Zeitung.* 86, 90, 14, 1936. *c.f. Superphosphate.* 9, 11, 1936.—The advantages of using an intimate mixture of superphosphate and a compound containing boron as a means of preventing the incidence in forage beet of crown and dry rot are described.

Comparative Experiments Relative to the Fertilizer Value of Phosphorite Meal, Superphosphate and Basic Slag. *Roczniki Nauk Rolniczych i Lesnych, Vol.* 19. *c.f. Superphosphate,* 9, 11, 1936.—Discussion is given of pot experiments designed to determine the fertilizer value of phosphorite meal as compared with superphosphate, basic slag and mono-calcium phosphate.

Relationship as between the Phosphorus Content in the Soil and Reaction Conditions. *Roczniki Nauk Rolniczych i Lesnych, Vol,* 22. *c.f. Superphosphate.* 9, 11, 1936.—The experiments described indicate that the water-soluble and citric-soluble phosphate contents of the soil are influenced by the reaction of the soil.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS AND FERTILISERS IN DECEMBER 1936, JANUARY AND FEBRUARY 1937

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	DECEMBER			JANUARY			FEBRUARY		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen Angus ...	44 6	40 6	38 6	43 7	40 1	38 4	43 7	40 1	38 0
Cross-bred (Shorthorn)	41 1	37 1	29 1	40 6	36 9	29 5	40 5	36 10	30 0
Galloway	39 11	36 9	...	39 3	36 3	...	39 5	35 11	...
Ayrshire	34 4	30 10	...	35 5	31 9	...	35 1	31 9	...
Blue Grey	43 5	40 7	39 1	43 0	40 6	38 5	42 11	40 6	38 6
Highland	41 8	39 4	38 0	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	13	5	...	14	5	...	14¼	5	...
†SHEEP—	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd per lb. d.	Ewes per lb. d.
Cheviot	11	10	6¾	11	10	6¾	11⅓	10¼	8¼
Half-bred	10½	9¾	6	10½	9½	6	11	9¾	7¼
Blackface	11	10	6½	11	9¾	6¾	11½	10¼	7¾
Greyface	11	10¼	6¼	11¼	10¼	6¼	11½	10¼	7
Down Cross	10¾	10	6½	10½	9¾	6¼	11	10	7½
†PIGS—	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.
Bacon Pigs	9 9	8 10	...	9 10	8 11	...	10 1	9 1	...
Porkers	10 6	9 5	...	10 7	9 6	...	10 9	9 7	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK: Monthly Averages of Prices (per head) at certain representative Scottish Markets—(*continued*).

Description	December			January			February		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
CATTLE—									
Aberdeen-Angus:	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*
Yearlings	14 8	11 17	...	14 9	11 13	9 15	14 3	11 11	9 0
Two-year-olds ...	17 19	15 0	...	18 4	14 11	...	18 11	14 19	...
Cross-bred (Shorthorn)									
Yearlings	13 13	11 5	9 19	14 5	12 0	10 5	13 5	11 3	10 4
Two-year-olds ...	17 4	15 2	13 18	17 17	15 10	15 3	17 9	14 13	...
Galloway:									
Yearlings	12 6	10 0	...	11 10	...	...	12 9	10 3	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Ayrshire:									
Yearlings	11 18	9 7	...	...	...	...	...	...	...
Two-year-olds ...	..	...	...	...	..	...	...	...	...
Blue Grey:									
Yearlings	...	...	...	...	...	...	12 10	...	...
Two-year-olds ...	...	...	...	...	...	...	..	...	...
Highland:									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Three-year-olds ...	...	...	...	...	...	...	...	...	...
DAIRY COWS—									
Ayrshire:									
In Milk	29 5	20 8	13 10	27 10	19 18	13 5	27 4	19 17	14 1
Calvers	29 0	20 11	14 14	28 9	20 14	14 13	26 18	20 13	14 16
Shorthorn Cross:									
In Milk	28 3	20 2	19 2	27 11	20 3	17 13	26 2	19 12	16 7
Calvers	27 8	18 7	16 7	27 6	18 19	15 3	25 13	18 8	14 11
SHEEP—	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Cheviot Hoggs ...	..	..	...	...	...	...	34 10	27 5	...
Half-bred Hoggs ...	...	...	...	44 0	37 1	34 8	48 3	40 11	34 0
Blackface Hoggs ...	28 10	20 2	..	27 11	21 8	...	25 3	19 5	...
Greyface Hoggs ...	40 5	31 10	...	42 7	33 6	...	41 7	34 6	...
Down Cross Hoggs	42 11	35 6	...	42 6	37 0	...	47 9	39 9	...
PIGS—									
(6 to 10 weeks old)	34 6	23 2	...	33 8	23 0	...	35 0	24 1	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	DECEMBER			JANUARY			FEBRUARY		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—										
Home-fed—										
Bullock or Heifer ...	1	6⅝	6½	8⅛	6⅞	6⅝	8½	6⅞	6½	8¼
	2	6	...	7	6⅜	...	7¼	6½	...	7¼
Bull	1	5½	4¾	5	5¾	4⅞	5	5¾	5	5
	2	5	...	4	5¼	...	4	5¼	..	4
Cow	1	4¼	4½	5	4⅜	4¾	5	4⅞	4¾	5
	2	3¾	...	4	3⅞	...	4	4	...	4
Irish—										
Bullock or Heifer ...	1	...	...	7¼	...	...	7¼	...	...	7⅛
	2	...	...	6¼	...	...	6⅛	...	...	6
Argentine Frozen—										
Hind Quarters ...	1	...	4½	...	...	4½	...	...	4¾	...
	2	...	4	...	...	4⅛	...	...	4½	...
Fore ,, ...	1	...	3⅜	...	...	3½	...	..	3¾	...
	2	...	3	...	...	3¼	...	...	3½	...
Argentine Chilled—										
Hind Quarters ...	1	6⅜	6¾	6½	6⅛	6⅜	6½	6	6½	6⅜
	2	...	6¼	...	...	6⅛	...	...	6¼	...
Fore ,, ...	1	4	4⅛	3¾	4	4	4	4	4⅛	3⅞
	2	...	3¾	. .	...	3⅝	3⅞	...	3⅞	3¾
Australian Frozen—										
Hind Quarters ...	1	3⅞	..	3⅞	4¼	...	3⅞	4⅜	...	4¼
Crops	1	2⅞	...	2⅞	3¼	...	2⅞	3⅜	...	3¼
New Zealand Frozen—										
Hind Quarters ...	1	3⅞	..	3⅞	4¼	...	3⅞	4⅜	..	4¼
Fore ,, ...	1	3	...	2¾	3⅛	..	2¾	3⅜	...	3⅛
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	10¾	9¾	10	10⅞	9¼	9⅝	11	9¼	10⅛
	60 lb. & over	10	...	9½	10	...	9⅛	10	...	9¼
,, Cross ...	under 60 lb.	10¾	9¾	10	10⅞	9¼	9⅝	11	9¼	10⅛
	60 lb. & over	10	...	9½	10	..	9⅛	10	...	9¼
Ewes, Cheviot ...	1	...	6	6	...	6¼	6¼	...	6⅞	7⅝
	2	...	...	5¾	...	...	5¾	...	...	7¼
,, Blackface ...	1	6¾	6	6	7	6¼	6¼	7¾	6⅞	7⅝
	2	5¾	...	5¾	6	...	5¾	7⅛	...	7¼
,, Cross	1	5¼	6	5½	5⅜	6¼	5½	5¾	6⅞	6⅜
	2	4¼	...	5	4⅜	...	5	4¾	...	5⅞
Argentine Frozen ...	1	...	...	3¾	...	...	3¾	...	...	4⅛
Australian ,, ...	1	...	5¼	3¾	...	5⅞	3¾	...	5¾	4¼
	2	...	4	...	...	4⅝	...	...	4¾	...
New Zealand ,, ...	1	...	...	4⅜	...	...	4⅜	...	...	4¾
	2	..	...	3¾	...	...	3¾	...	...	4¼
LAMB:—										
Home-fed	1	...	...	10½	...	...	10⅛	...	...	10⅝
	2	...	...	10⅛	...	...	9⅝	...	...	10¼
New Zealand Frozen	1	...	8	7⅛	...	8⅜	7⅛	...	8⅝	7
	2	...	7	. .	...	7⅜	...	...	7¾	...
Australian ,, ...	1	...	...	6⅜	...	...	6⅜	...	...	6¾
Argentine ,, ...	1	...	...	6⅜	...	...	6¼	...	...	6½
		per cwt. *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*
PORK:—										
Home-fed	1	84 0	82 7	79 4	84 0	84 0	88 0	84 0	84 0	88 0
	2	52 3	...	72 4	56 0	...	79 4	56 0	...	79 4
Imported	1	...	...	63 0	...	...	65 4	...	..	65 4

EGGS: Monthly Average Wholesale Prices at Aberdeen Kilmarnock, Lanarkshire and Glasgow.

(Compiled from returns received from the Department's Market Reporters)

DESCRIPTION	WEIGHT PER 120	QUALITY	DECEMBER		JANUARY		FEBRUARY	
	lb.		s.	d.	s.	d.	s.	d.
ABERDEEN—								
Country (ungraded) per doz.	...	1	1	8½	1	2¾	1	4½
	...	2	...		1	0¾	1	3¾
KILMARNOCK—								
Country (ungraded) per doz.	...	1	2	1	1	6¼	1	6½
LANARKSHIRE—								
Country "Standards" per doz.	...	...	2	5	1	9¼	1	8¾
GLASGOW—								
Unstamped Scottish Eggs ... per doz.	...	1	2	2	1	6¾	1	8
National Mark—								
"Specials" ... ,,	...	...	2	3	1	7	1	7¾
"Standards" ... ,,	...	...	2	1	1	4½	1	6¾
"Mediums" ... ,,	...	...	1	8	1	2¾	1	4¾
Ungraded ... ,,	...	1	1	9½	1	2¾	1	5½
"Specials" ... per 120	...	...	22	5	15	8	16	4
"Standards" ... ,,	...	...	20	7	13	5	15	5
"Mediums" ... ,,	...	...	16	10	12	1	13	9
Ungraded ... ,,	...	1	17	9	12	3	14	7
Northern Ireland ,,	17	...	21	1	14	11	15	7
,, ,,	15½	...	19	6	13	7	14	9
,, ,,	14	..	16	6	12	4	13	5
,, (Duck) ,,	...	1	...		15	0	14	0
Irish Free State ... ,,	16	...	19	4	13	2	13	4
,, ... ,,	15	...	18	6	12	2	12	7
,, .. ,,	14	...	15	11	11	2	11	5
,, (Duck) ,,	...	1	14	5	12	4	12	4
Australian ... ,,	17	...	13	5	...		...	
,, ... ,,	16	...	13	0	...		...	
,, ... ,,	15	...	12	5	..		...	
,, ... ,,	14	...	10	8	...		...	
Belgian ... ... ,,	15½	..	...		10	3	...	
Danish ... ... ,,	17	...	15	2	11	8	...	
,, ... ,,	15½	...	13	10	10	7	11	3
,, ... ,,	14	...	11	7	9	0	10	2
,, ... ,,	13	...	...		8	9	9	5
Polish ... ... ,,	...	...	8	4	7	0	6	6

PROVISIONS: Monthly Average Wholesale Prices (per cwt.) at Glasgow.

DESCRIPTION	QUALITY	DECEMBER		JANUARY		FEBRUARY	
		s.	d.	s.	d.	s.	d.
BUTTER—Scot. Creamery (uns'lt'd)	1	...		...		...	
Irish Creamery	1	111	10	...		...	
,, ,, (unsalted) ...	1	...		...		...	
Australian	1	104	0	100	6	93	8
New Zealand	1	105	10	98	6	90	9
Danish	1	117	7	114	6	124	6
,, (unsalted)	1	126	0	...		...	
Dutch	1	102	10	100	0	103	6
Latvian	1	102	2	101	3	103	9
Swedish	1	108	5	104	0	112	6
CHEESE—Cheddar	1	88	0	88	0	88	0
,, ,, ...	2	74	5	73	0	73	0
,, ,, Loaf	1	96	0	96	0	96	0
Dunlop	1	86	0	86	0	86	0
	2	80	0	...		...	
Canadian	1	78	0	78	0	76	0
New Zealand (Coloured) ...	1	68	7	60	0	57	3
,, (White)	1	68	7	60	0	57	3
*FARMHOUSE CHEESE—C'd Cheddar	...	73	2	72	0	72	0
White Cheddar	...	75	2	74	0	74	0
Dunlop	...	73	2	72	0	72	0
Cheshire	...	0	7⅝	0	7¾	...	
*FACTORY CHEESE—C'l'r'd Cheddar	...	67	9	...		...	
White Cheddar	...	...		...		...	
Dunlop	..	...		...		...	
HAMS—Irish (Smoked)	1	142	0	157	0	162	0
	2	124	0	142	0	147	0
,, (Boneless)	1	120	0	129	6	134	0
American (Short Cut, Green) ..	1	93	7	96	8	100	0
Canadian ,, ,, ,, ...	1	...		100	0	100	0
BACON—Ayrshire (Rolled) ...	1	125	1	130	8	126	0
English Wiltshire (Green) ...	1	98	7	101	0	95	0
,, (Dried or Smoked ...	1	106	7	109	0	103	0
Irish (Green, Wiltshire Style) ...	1	96	2	98	0	93	0
	2	93	2	96	0	...	
,, (Dried or Smoked) ...	1	102	2	104	0	99	0
	2	99	2	97	6	94	0
,,(Long Clear, rolled with skin on)	1	114	2	116	0	111	0
	2	...		102	0	98	0
Canadian Sides (Green) ...	1	88	2	91	6	83	0
Danish Sides	1	102	2	103	0	97	0
Dutch (Green, Wiltshire Style)	1	103	2	104	0	98	0
LARD—American	1	72	0	76	0	75	0

* Farmhouse and Factory Cheese Prices quoted are as supplied by the Scottish Milk Marketing Board in respect of Cheese supplied to Brokers

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter)

DESCRIPTION		QUALITY	DECEMBER		JANUARY		FEBRUARY	
			s.	d.	s.	d.	s.	d.
FRUIT :—								
Apples—								
British—	per							
Bramley Seedling	... 56 lb.	1	6	0	...		...	
Irish	... ,,	1	...		5	3	5	6
American	... case.*	1	12	8	12	4	11	8
	barrel**	1	20	1	16	10	19	9
Pears—								
Californian	... case.*	1	14	6	14	10	16	3
VEGETABLES :—								
Beet	.. cwt.	1	5	0	5	0	5	0
Brussels Sprouts—								
Scottish	... cwt.	1	12	0	10	8	10	6
English ...	net 20 lb.	1	2	11	2	8	2	5
Cabbage—								
Coleworts	... dozen.	1	1	0	1	0	1	0
Red	... ,,	1	3	0	3	0	3	0
Savoy	... ,,	1	1	7	1	9	1	9
Carrots—								
British	... cwt.	1	5	0	5	0	5	0
Cauliflowers—								
Broccoli, Cornish	... dozen.	1	4	7	4	0	2	11
Other British	... ,,	1	4	0	3	0	2	5
French	... ,,	1	...		4	6	3	3
Celery	... bunch.	1	1	6	1	6	1	6
Washed	box, 24 heads	1	3	5	3	3	2	6
Cucumbers	... dozen.	1	22	6	...		...	
Greens	... 120 heads.	1	9	0	10	0	10	0
Leeks	dozen bunches.	1	2	6	2	6	2	4
Lettuce—								
Cabbage	... dozen.	1	1	2	3	3	...	
Onions—								
Spring	... bunch.	1	0	6¼	0	6	0	6
Dutch	... cwt.	1	5	4	5	5	5	0
Hungarian	... ,,	1	6	8	...		...	
Valencia	... case.**	1	13	0	12	2	12	6
Parsley	... cwt.	1	12	0	14	0	12	0
Parsnips	... ,,	1	8	0	8	0	6	6
Radishes	dozen bunches.	1	1	6	1	6	2	0
Rhubarb	... cwt.	1	...		35	0	22	6
Spinach	... stone.	1	2	10	3	3	4	0
Tomatoes—								
Scottish	... lb.	1	0	7	...		...	
Canary	... ,,	1	0	3¾	0	5¼	0	5¾
Channel Islands	... ,,	1	0	4	...		...	
Turnips	... cwt.	1	1	9	1	9	1	9
Vegetable Marrow	... dozen.	1	4	0	4	0	...	

* 40 lb. (approx.). ** 9 stone (approx.).

POTATOES: Monthly Average Wholesale Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	FIRST EARLIES	SECOND EARLIES	LATE VARIETIES			
				RED SOILS		OTHER SOILS	
				Golden Wonder	Other	Golden Wonder	Other
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
		DECEMBER					
Aberdeen ...	1	...	...	...	...	...	5 4 0
Dundee ...	1	...	...	...	...	6 19 0	5 12 0
Edinburgh ..	1	...	5 10 0	7 10 0	...	7 0 0	5 10 0
Glasgow ...	1	...	5 7 0	...	...	7 0 0	5 14 0
		JANUARY					
Aberdeen ...	1	..	...	..	...	...	5 8 2
Dundee ...	1	...	...	...	...	7 0 0	5 5 0
Edinburgh ...	1	...	5 6 3	7 10 0	...	7 10 0	5 10 4
Glasgow ...	1	...	5 6 8	...	..	7 0 0	5 13 9
		FEBRUARY					
Aberdeen ...	1	...	...	...	...	6 0 0	5 5 0
Dundee ...	1	...	...	...	...	7 0 0	5 6 9
Edinburgh ...	1	...	5 7 6	...	...	7 10 0	5 11 3
Glasgow ...	1	...	...	...	...	7 5 0	5 10 0

ROOTS, HAY, STRAW AND MOSS LITTER: Monthly Average Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	ROOTS			HAY		STRAW			MOSS LITTER
		Carrots	Yellow Turnips	Swedes	Rye Grass and Clover	Timothy	Wheat	Barley	Oat	
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
		DECEMBER								
*Aberdeen ...	1	...	...	..	82 0	...	..	...	29 0	...
†Dundee ...	1	...	‡14 5	‡16 10	121 0a 111 0b	...	71 0	...	75 0	...
‖Edinburgh ...	1	...	...	...	95 0a 95 0b	...	46 0	38 9	46 0	...
aGlasgow ...	1	...	...	..	97 0	101 0	60 6	...	60 6	32 6c
		JANUARY								
*Aberdeen ...	1	...	...	...	88 9	...	..	...	31 3	..
†Dundee ...	1	...	...	‡16 6	130 0a 120 0b	...	81 8	...	91 3	...
‖Edinburgh ...	1	...	...	...	106 3a 106 3b	...	58 9	52 6	58 9	...
aGlasgow ...	1	.	...	...	108 9	113 9	68 9	...	72 6	39 6c
		FEBRUARY								
*Aberdeen ...	1	...	...	...	103 9	..	...	...	35 0	...
†Dundee ...	1	...	...	‡17 6	135 0a 125 0b	...	90 0	...	93 9	...
‖Edinburgh ...	1	...	...	...	110 0a 110 0b	...	63 9	57 6	63 9	...
aGlasgow ...	1	...	...	...	112 6	117 6	70 0	...	75 0	43 9c

* Ex farm, loose.
† Baled straw, delivered in town.
‡ Delivered in Town.

‖ Bunched or baled straw, delivered.
a Baled and delivered. b Delivered, loose.
c Home moss litter, in 1½-cwt. bales.

FEEDING STUFFS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	DECEMBER		JANUARY		FEBRUARY	
	Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
Linseed Cake—	£ s. d.	£ s d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Home	9 5 9	9 4 6	9 9 8	9 7 6	9 8 5	9 7 6
Foreign	9 1 0	...	9 7 10	9 5 0	9 7 6	...
Decort. Cotton Cake	8 18 6	8 15 0	9 9 8	9 1 3	9 5 11	9 3 9
Undecort. Cotton Cake—						
Egyptian (Home manufactured)	5 17 6	6 2 6	6 7 6	6 4 2	6 3 9	6 2 6
Palmnut Kernel Cake	8 11 0	...	9 0 0	...	...	...
Groundnut Cake, undecort.—						
(50% Oil and Album.)	8 15 0	8 12 6	9 6 11	...	8 18 2	...
(54% ,, ,,)	8 18 6	...	9 9 5	...	9 1 3	...
Maize Germ Cake, Home mfd.	7 19 6	...	8 5 10	...	8 3 9	...
Rice Meal	6 9 0	...	7 2 6	...	7 1 7	...
Maize Germ Meal	7 5 0	...	7 7 6	...	7 5 4	...
Bean Meal	8 6 7	8 7 0	8 18 9	8 13 9	8 19 1	8 15 0
Fish Meal	14 14 0	14 11 0	15 3 9	15 0 0	14 15 0	14 17 6
Maize Meal—						
Home manufactured	6 16 0	6 18 0	7 2 6	7 0 0	7 1 11	6 18 2
Barley Meal	8 16 9	8 7 0	9 15 0	9 7 6	9 14 5	9 6 3
Locust Bean Meal	7 13 0	7 15 0	8 0 0	8 8 2	8 15 0	8 7 6
Locust Beans (Kibbled and Stoned)	6 15 0	6 10 0	7 5 11	7 3 2	7 15 0	7 9 5
Maize Gluten Feed (Paisley)	7 5 0	...	7 13 9	...	7 15 0	...
Maize—						
Plate	5 18 11	5 17 6	6 5 0	6 2 6	6 6 11	6 0 0
African	7 12 3	...	8 3 9	...	8 10 0	...
Oats—						
Home	7 7 0	8 4 5	8 8 2	8 8 2	8 0 0	8 6 11
Barley—						
Imported	8 3 9	7 15 6	8 17 6	8 13 2	8 15 11	8 11 3
Malt Culms	5 19 0	4 19 0	6 6 11	5 11 11	6 15 8	...
Brewer's Grains (dried)	6 11 6	5 16 6	7 0 4	6 4 5	7 0 0	6 7 6
Distillers' Malt Grains (dried)	6 19 6	...	7 11 3	6 7 6	7 9 8	...
Distillers' Mixed Grains (dried)	6 19 5	...	7 12 6	...	7 11 3	...
Wheat—						
Home	9 15 0	9 15 0	11 2 6	10 10 0	10 0 8	8 18 9
,, (Poultry)	9 10 0	9 5 0	10 6 3	...	9 11 3	...
Middlings (Fine Thirds or Parings)	8 3 9	7 16 6	8 19 1	8 12 10	8 11 11	8 9 5
Sharps (Common Thirds)	7 14 9	7 10 0	8 14 5	8 8 9	8 8 2	8 5 8
Bran (Medium)	7 16 9	7 13 3	8 15 0	8 8 9	8 10 0	8 11 3
,, (Broad)	8 2 8	8 3 0	9 0 0	8 18 9	8 14 8	8 19 5
Feeding Treacle	5 7 6	6 0 0	5 7 6	6 0 0	5 7 6	6 0 0
Crushed Linseed	18 2 0	...	18 10 0	...	18 10 0	...
Beans—						
China	7 10 0	7 6 11	8 1 7	7 17 6	8 0 11	8 0 0
Rangoon (White)	7 2 6	...	7 4 2	...	7 3 5	...
Peas—						
(Calcutta)	10 1 8	...	10 5 0	...	10 6 8	...
Karachi (White)	9 17 6	...	9 17 6	...	10 3 4	...
Sugar-Beet Pulp (English)	6 15 0	6 7 6	7 5 0	6 9 5	...	6 10 0
Linseed Oil, per gall.	0 4 0	...	0 4 0	...	0 4 0	...

FERTILISERS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	Guaranteed Analysis	DECEMBER						JANUARY						FEBRUARY					
		Glasgow			Leith			Glasgow			Leith			Glasgow			Leith		
	%	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Nitrate of Soda*	N. 15.5	7	12	6	7	12	6	7	12	6	7	12	6	7	12	6	7	12	6
Sulphate of Ammonia (Neutral and Granular)* ...	N. 20.6	7	0	6	7	0	6	7	2	0	7	2	0	7	3	6	7	3	6
Calcium Cyanamide†	N. 20.6	7	0	0		...		7	1	3	7	1	3	7	2	6	7	1	3
Nitrochalk* ...	N. 15.5	7	5	0	7	5	0	7	5	0	7	5	0	7	5	0	7	5	0
Superphosphate ...	P.A. 13.7	2	12	6	2	12	6	2	16	0	2	16	0	2	16	0	2	16	0
,, ...	,, 16.0	2	17	6	2	17	6	3	1	0	3	1	0	3	1	0	3	1	0
,, ...	,, 18.3	3	2	6	3	2	6	3	6	0	3	6	0	3	6	0	3	6	0
Ground Mineral Phosphate § ...	P.A. 26	2	12	6	2	12	6	2	15	0	2	12	6	2	15	0	2	12	6
,, ,, ,, § ...	,, 34		...			...		3	15	0	3	10	0	3	15	0	3	10	0
Potassic Mineral Phosphate	P.A. 18 Pot. 9		...		3	11	3		...			..			...			...	
,, ,, ,,	P.A. 18 Pot. 10	3	16	3		...		3	16	3		...		3	16	3		...	
,, ,, ,,	P.A. 20 Pot. 7.5	3	11	3		...		3	11	3		...		3	11	3		...	
,, ,, ,,	P.A. 21 Pot. 6		...		3	6	3		...			...			...			..	
,, ,, ,,	P.A. 21 Pot. 10		...		3	17	6		...			...			...			...	
Kainit (in bags) ...	Pot. 14	3	1	3	3	0	0	3	1	3	3	0	0	3	1	3	3	0	0
Potash Salts ...	Pot. 20	4	2	6	4	0	0	4	2	6	4	0	0	4	2	6	4	0	0
,, ,, ...	,, 30	5	1	3	4	15	0	5	1	3	4	15	0	5	1	3	4	15	0
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	8	2	6	7	15	0	8	2	6	7	15	0	8	2	6	7	15	0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48.6	9	15	0	9	7	6	9	15	0	9	7	6	9	15	0	9	7	6
Steamed Bone Flour	N. 0.8 P.A. 28	5	7	6	5	5	0	5	7	6	5	5	0	5	7	6	5	5	0
Bone Meal (Indian)	N. 4 P.A. 20	6	12	6	6	12	6	6	12	6	6	10	0	6	12	6	6	10	0
Basic Slag‡ ...	P.A 12	2	5	0		...		2	7	6	*b*1	3	3	2	7	6	*b*1	3	3
,, ,, ...	,, 13	2	7	0	*a*1	14	6	2	9	6	*b*1	5	6	2	9	6	*b*1	5	6
,, ,, ...	,, 14	2	9	0	*a*1	16	6	2	11	6	*b*1	7	6	2	11	6	*b*1	7	6
,, ,, ...	,, 15		...		*a*1	18	6		...		*b*1	10	6		..		*b*1	10	6
,, ,, ...	,, 15¾		...		*a*2	0	0		...		*b*1	12	6		...		*b*1	12	6
,, ,, ...	,, 16½		...			...			...		*b*1	15	6		...		*b*1	15	6
Potassic Slag ...	P.A. 12 Pot. 6		..		3	10	0		...			...			...			...	

Abbreviations:—N.=Nitrogen; P.A.=Phosphoric Acid; Pot.=Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

§ Fine grist, 90 per cent fineness through prescribed sieve.

‡ Basic Slag: At Glasgow—80 per cent citric soluble and 80 per cent fineness; F.o.r., 6-ton lots.

a Basic Slag: At Leith—80 per cent fineness, no guarantee of citric solubility, F.O.R. Grangemouth or Bo'ness.

b Basic Slag: At Leith—80 per cent fineness, no guarantee of citric solubility, *ex* Middlesborough, in wagon loads, carriage varies by from 15s. to 17s. per ton.

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THE CHEMICAL CONTROL OF THE SHEEP MAGGOT FLY

(*Lucilia sericata* Meigen)

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UNDER the direction of James Ritchie, M.A., D.Sc., Professor of Natural History, University of Aberdeen, now of the University of Edinburgh, research into problems connected with the Sheep Maggot Fly or Sheep Blowfly has been carried out since 1933, and reports on certain aspects of these investigations have been issued by Ritchie (1), by Ratcliffe (2) and by Morison (3). As part of the joint scheme, in May 1933 there was commenced an investigation into the possibility of efficient chemical control. Progress during the first year was hindered because of the absence of data on which the work could be based. In this country, previous work had dealt almost exclusively with the control of the sheep scab mite, *Psoroptes communis* var. *ovis*, and scanty information was available as to the effect of the various measures upon other pests the importance of which has been increasingly recognised (4). In Australia (5, 6, 7) and South Africa (8, 9) the control of "Sheep Blowflies" has received much attention, but the factors involved differ so markedly from those in Great Britain that few of the data could be made use of.

In conjunction with the chemical investigations, field surveys were made to ascertain the chief causes of strike and to account for the inadequacy of present dipping methods. The information so obtained proved valuable in the elaboration of suitable dressings and methods for their application.

Causes of Strike.—Clean, healthy sheep are rarely attacked, so that the presence of some abnormal attracting substance on the fleece is necessary. All the factors rendering a sheep liable to strike have not been determined, but investigations are proceeding at Bangor (10, 11, 12) and Aberdeen, and the importance of the following has been recognised.

1. *Soiling of the fleece by fæces and urine.*—This is the most

common and powerful agent in attracting the fly, and no dip or dressing has been found wholly effective against it. The following experiment illustrates the importance of such soiling. In a flock of 80 sheep which had escaped fly attack, ten were treated by wetting the fleece with water and rubbing in sheep fæces and allowed to remain with the flock. On the third day one of the treated sheep was struck and the other nine within four days; during the same time the untreated sheep remained clear.

Scouring is the most important cause of fleece soiling, and investigation into methods for its control must be an essential part of future work. Where only a few sheep are affected, removal of the soiled wool and washing of the surrounding part can be carried out with success, but this is impracticable where large numbers are involved. Bacteria and parasitic worms are recognised as the cause of the very severe scouring met with in some flocks, but in the North of Scotland nutritional factors appear to be of importance. Dr Robertson, Zoology Department, North of Scotland College of Agriculture, informs me that in the cases investigated by him worms were not the cause of the definite disturbance of the digestive tract noted at autopsy. Further work on the nutritional aspect is proceeding, and it is hoped that restricted grazing periods as practised with dairy cows may have a beneficial effect. The failure of dressings to cope with soiling of the fleece appears to be due to the fæces on the fleece putrefying, and overcoming the repellent properties of the substances in the dressing.

2. *Foot-rot.*—Several cases of strike on the under surface of the chest region were noted in apparently clean sheep which normally would have escaped. All these sheep were found to suffer from foot-rot, and soiling of the wool with discharge from the affected feet occurred while the animals lay upon the ground. The discharge strongly attracts the fly, and when the maggots hatch they migrate to the shoulder, where moisture conditions are more favourable.

Treating the affected sheep with the dressing described later, greatly diminished the incidence of strike from this cause.

3. *Wool-rot.*—During alternate periods of sunshine and rain this condition appears in the fleece of some sheep. It is due to bacterial activity, and is characterised by a browning of the wool and the production of fly-attracting substances.

4. *Rabbits.*—The increase in rabbits in some parts has been blamed by many sheep farmers for contributing to the increase in strike, and observation showed that strike was very common where sheep lay in the shelter of rabbit burrows. The most obvious explanation seemed to be that the wool became soiled with rabbit fæces, and the following trial was made. Three of a flock of 20 sheep which were free from strike were dressed with a mixture of rabbit fæces in water. Within seven days the three treated sheep had been struck, while the remainder continued free. The weather during the experiment was warm and showery. The experiment, if confirmed on more extensive trial, would suggest that it is desirable to reduce rabbits on sheep grazings.

5. *Wounds and Sores.*—Discharge, especially of a purulent

nature, from wounds or sores is strongly attractive to the fly, so early treatment with a dressing that will bring about rapid healing and also repel flies is desirable. A common cause of sores is burning by the use of too strong solution of dip both in routine dippings and as a dressing. The exudate from the blisters which form causes soiling of the fleece over considerable areas.

6. *Unhygienic and Improper Dipping.*—Dipping in a bath where the solution has become grossly contaminated by urine and fæces leads to a very common cause of strike. The following case illustrates this point. The flocks from two adjacent holdings on Deeside were taken upon the same day to a communal dipper. One of 80 ewes and lambs was the first, the other of 120 ewes and lambs the last lot of about 1500 individuals put through during the day. There was no change of solution except that more was added from time to time to maintain the bulk. The first lot remained free from strike for 18 days, while cases appeared in the lot put through last within 7 days.

A summary of the causes of strike in 179 sheep out of a flock of 620, over a period of 6 weeks during the months of June and July 1935 is shown in Table I.

TABLE I

Cause	Number Struck	Number Restruck	Time of first strike after dipping
Scouring	114	42	11 days
Foot-rot	34	10	8 days
Wool-rot	16	7	16 days
Wounds and Sores ...	15	14	3 days

The chief reasons why present methods of dipping fail to control strike may be summarised as follows:—

(*a*) All the common dips are water soluble and are therefore readily washed off the fleece by rain. A number of sheep were dipped in a bath, the dip in which contained colouring matter. All the colouring matter was washed off the wool within fourteen days. In some cases heavy rain washed off the dip in from four to six days. Chemical tests made upon the outside layers of the fleece failed to show the presence of arsenical dip fifteen days after dipping. This removal of the antiseptic allows bacterial decomposition to proceed, and it is accelerated by the introduction into the fleece of putrefying matter.

(*b*) Under some conditions the dip does not penetrate to the skin, but only wets the outside layer of the fleece. This is partly due to insufficient time of immersion in the dipping bath and partly to deficiencies in wetting and penetrating powers of the dipping solution. Although the Ministry of Agriculture's Regulations for dipping state that sheep must be immersed in the dipping solution for one minute, this regulation is rarely carried out in practice, the average time being from ten to fifteen seconds. In one district where the writer saw over thirty thousand sheep dipped, the longest time any sheep was in the bath was 22 seconds. Under these conditions, dipping solutions must have a very high penetrating power if they are to reach the skin. The wetting and penetrating properties are largely influenced by the emulsifying agents used. Many dips contain soft soaps for a wetting agent, but these are generally low in penetrating power. The wetting and penetration powers are still further reduced by the contamination of the dipping solution with fæces.

(*c*) The presence of dried fæces on the wool is a common cause of failure. The sheep are rarely immersed long enough for the dip to saturate this material, and, after drying, the untreated core of fæces undergoes continued decomposition and attracts the fly.

Treatment.—The first essential treatment is to remove the cause of strike. Some of the conditions inducing strike, however, cannot be overcome by chemical treatment. The repeated soiling of the wool by fæces or by urine will soon neutralize the action of the relatively small amount of chemical compounds that can be deposited upon the wool by dipping. Where the inducing cause cannot be entirely removed, as in scouring, it may be possible to make conditions in the rest of the wool unfavourable to the development of larvae.

The investigation into chemical treatment with a view to preventing strike was conducted along the following lines:—

(1) Preparation of a dip possessing properties which could prevent strike.
(2) Determination of methods of applying the solution to the fleece.
(3) Preparation of a dressing for treatment of struck sheep.
(4) Treatment for foot-rot.

(1) **Dip.**—The requirements of a dip to combat sheep maggot fly are:—

(*a*) Persistence on the wool for a long time and resistance to being washed off by rain.
(*b*) High antiseptic properties to prevent bacterial activity in the fleece.
(*c*) Definite fly-repellent properties.
(*d*) Power of penetrating and wetting the fleece rapidly.
(*e*) It should mix readily with water to form a stable emulsion.
(*f*) It must not stain the wool.
(*g*) Cheapness to make it a commercial proposition.

Before an experimental dip was evolved to satisfy these requirements a large number of substances had to be tried by laboratory experiments. The following is a short account of the experiments made.

(*a*) *Persistence.*—For a dip to persist against the action of rain it must possess waterproofing properties. Of the various methods tried it was found that the simplest way of waterproofing was by the use of an oily emulsion. By this method the oil, having the antiseptic and fly-repellent material dissolved in it, forms a film over the fibres of the wool and on the skin.

The choice of a suitable oil was a very important consideration. Of the many oils tested, the mineral oils used by manufacturers of brilliantine were found to be the most suitable. Vegetable and animal oils, when in low concentration in an emulsion, were very readily absorbed by the skin and disappeared in a few hours. The oil finally selected was a water-white mineral oil of over 98% purity with a specific gravity of 0·865, viscosity 130 sec Redwood 1, at 70°F. and an open flash point of 330°F. This oil was tested for us by Professor Campbell of the Materia Medica Department, University of Aberdeen, who found that it had no evil effect on rabbits and persisted on the skin for over three weeks. Later, no harmful effects were noticed on the skin of pigs which received dressings every three days for a month.

(*b*) *Antiseptic Properties.*—For the purposes of the Sheep-dipping Orders, the choice of an antiseptic for a sheep dip is limited by the requirement laid down by the Ministry of Agriculture, whose regulations state that all recognised dips when diluted for use must contain 0·18% water-soluble arsenic trioxide, or 0·1% nicotine, or 0·76% total tar oils including 0·36% tar acids. Nicotine was first considered, but it is too expensive to incorporate in a dip in this country. The final choice of the antiseptic lay in its suitability for incorporating in an oily emulsion. The arsenical compounds have the disadvantage that they are insoluble in mineral oils. They may be mixed with the mineral oil in a water emulsion, but for the substance to persist against the action of rain it must be either insoluble in water or dissolved in oil. The phenolic compounds are soluble in mineral oils, but the cruder forms stain the wool and make it unsuitable for manufacture. The antiseptic finally selected was pale straw-coloured cresylic acid of 99% purity. This material is soluble in mineral oil, does not stain the wool, and is a much more powerful antiseptic than ordinary carbolic acid, but is slightly more expensive.

(*c*) *Repellent Properties.*—Data on the properties repellent to "Blowflies" of various substances have been obtained by Roark (13) and Laake (14) in the United States of America and by various Australian workers (15). Of the materials mentioned by these workers only *Oleum picis* (rect.) was found to be suitable for incorporating in the dip. This substance, however, had to be used in such high concentrations, usually 5 to 10% in the diluted dip, as to make its use impracticable.

Two laboratory methods were used for testing the repellent properties of different substance. One was to treat pieces of liver with the substance and place them in a cage containing both flies and maggots, and note their reactions. The other method was to take a number of jars of similar capacities, place ten flies in each and divide them into two series. Chloroform was placed in the jars of the first series and the material under test in the jars of the second series, equal weights being taken in each case. The average time taken to kill the flies in each series was noted, the chloroform being taken as standard. Of the substances tested, paradichlorobenzene and monochloronaphthalene were found to possess the highest killing and repellent properties. These two substances were then incorporated in mineral oil emulsion and tried on the skins of rabbits. The paradichlorobenzene emulsions had no effect on the skin, but the monochloronaphthalene emulsions attacked the skin and even in very weak solutions were apt to cause dermatitis.

(*d and e*) *Penetration, wetting and stability.*—These requirements should be considered together, because penetration, wettability and methods of emulsification are closely related.

Before a mineral oil can be mixed with water it must be emulsified. This is generally brought about by mixing some form of soap, or an emulsifying oil with it. Particular attention has been paid to emulsifiers in research on plant protection, and recent discoveries in that field show that a quick-breaking emulsion is much more efficient than a tight emulsion. An attempt was made to apply this knowledge to sheep dips, and after many months work in the laboratory an emulsion, with Di Glycol Oleate as emulsified, was obtained, which appeared to satisfy our requirements. This emulsion was tested in the laboratory by comparing the amounts retained by given weights of wool, and it was found much more efficient than any of the other emulsifiers used. When it was tried in the field by immersing sheep in it, it failed to penetrate the fleece beyond the outside layers. Other quick-breaking emulsions were tried, but in every case these emulsions broke on the outside of the fleece, forming a waterproof layer which prevented the dip from penetrating the fleece.

Work was then directed to finding an emulsifying agent which would give a stable emulsion that would penetrate to the skin. The most suitable agent found was a black missible oil type of emulsifier named Whitcol J. This substance forms a one-solution emulsion which penetrates the fleece very rapidly. Unclipped Blackfaced ewes immersed in this emulsion were wetted to the skin in ten seconds. The early emulsion tried did not wet the fleece satisfactorily, but on introducing wool grease into the mixture the wetting power was greatly increased. This is due to the fact that the wool grease in the dip brings it into intimate contact with the similar fat on the fleece.

(*f*) *Staining.*—After repeated trials with the dip evolved, no case has been reported of any harmful effects either on the health of the animal or on the fleece.

Composition.—The dip finally adopted as most satisfactory had the following composition:—

	Parts by weight
Water-white mineral oil	38
Pale straw-coloured cresylic acid, 99% purity	25
Paradichlorobenzene	25
Crude brown Yorkshire wool grease . .	12
	100

To 66 *parts by volume* of this mixture add *Oleum picis* (rectified) 4 *parts by volume* and Whitcol J. 30 *parts by volume.*

Preparation of Dip.—The mineral oil, cresylic acid, and wool grease are mixed together in a boiler and warmed gently, at the same time being stirred, until the wool grease is dissolved. The paradichlorobenzene is then added while the mixture is still warm, about 60-70°C., and stirred at intervals until dissolved. The mixture is allowed to cool, and then to 66 parts by volume of this oily solution must be added 4 parts by volume *Oleum picis* (rectified) and 30 parts by volume of Whitcol J. and the mixture gently stirred. For use, one part of this mixture is diluted with forty parts of water.

This formula does not comply exactly with the Ministry of Agriculture's requirements, because cresylic acid is substituted for ordinary tar oils. The percentage of cresylic acid is higher than the percentage of tar acids required, but the mixture is deficient in tar oils. It is not advisable to increase the percentage of cresylic acid above 0·5%, as the great increase in wetting power obtained in this emulsion will damage the sheep. In some cases where the concentration was increased to 0·7%, many of the sheep collapsed on coming out of the dipper, but revived after about an hour and showed no ill effects the next day. The addition of *Oleum picis* promotes rapid healing of wounds and sores.

(2) **Methods of applying the Dipping Solution.**—The oil emulsion was first tested alongside a proprietary water-soluble arsenical dip by dipping in the usual manner. This method did not prove very satisfactory, because the dipping solutions became contaminated with fæces and necessitated the cleaning out of the bath at regular intervals. To get over this difficulty it was decided to investigate the possibility of spraying the solution on to the sheep. At first an ordinary hand-sprayer was used, but this method took a very long time before a sheep was properly treated. The hand-spraying, however, was so successful in preventing strike as to warrant further trials. The spraying experiments, which are described later in this paper, showed that to prevent strike particular attention must be paid to the breech and the chest. These two areas are most easily fouled by putrifying matter, the breech by fæces and the breast from material from the feet. The question of spraying by a power unit was considered, but at that time we had neither the means nor the engineering knowledge to carry out the work. Fortunately Mr R. Edminson, a chemical engineer of Perth, offered to undertake the engineering problem and placed a set of equipment at our disposal. This equipment consists of two main parts—a power unit and a spraying cabinet.

The power unit consists of a 3½ H.P. petrol engine, a three-throw pump working up to 400 lb. pressure and an 80-gallon tank, mounted together on a movable chassis. The spraying cabinet is illustrated and consists of a galvanised chamber containing the spraying jets. This system eliminates handling; the sheep enter from a fank at one end of the cabinet and leave by the other end after spraying. The unit has been designed with a view to portability so that it can be taken on a motor lorry to the sheep. This is of great value in the case of hill farms, where sheep may have to walk several miles to the dipper. Some doubt has been expressed as to whether the dipping solution applied by spraying will penetrate to the skin. Experiments have shown that with the proper selection and placing of the spraying nozzles this property depends upon the dipping solution. Quick-breaking emulsions and dipping solutions with a high viscosity will not penetrate to the skin no matter whether they are sprayed or whether the animal is immersed in them in a bath. An emulsion with high penetrating power and sprayed with a coarse jet soaks right through to the skin immediately. No claim can be made as yet that the spraying cabinet is perfect, but with certain modifications based on the experimental work this year, there seems little doubt that this method will eventually reach a high stage of efficiency. The power unit is designed to work two spraying cabinets, and each cabinet can spray on to the sheep half a gallon of solution at 200 lb. pressure in twenty seconds.

Dipping and Spraying Experiments.—The oil emulsion dip was tested alongside a proprietary water soluble arsenical dip which had been found to be the most effective proprietary dip in preventing strike.

Experiment I.—In this experiment, which lasted from 10th July to 14th August 1935, a flock of 450 lambs was divided into 3 groups of 150 each, and the groups were treated as follows:—

Group I—Undipped.
Group II—Dipped with the oil emulsion dip.
Group III—Dipped in the arsenical dip.

Observations were made each day and the record of strike is shown in Table II.

TABLE II

Undipped				Oil Emulsion Dip				Arsenical Dip			
Number of Strikes		Scouring	Not Scouring	Number of Strikes		Scouring	Not Scouring	Number of Strikes		Scouring	Not Scouring
Tail	Other Parts			Tail	Other Parts			Tail	Other Parts		
83	9	64	28	24	0	21	3	27	0	21	6

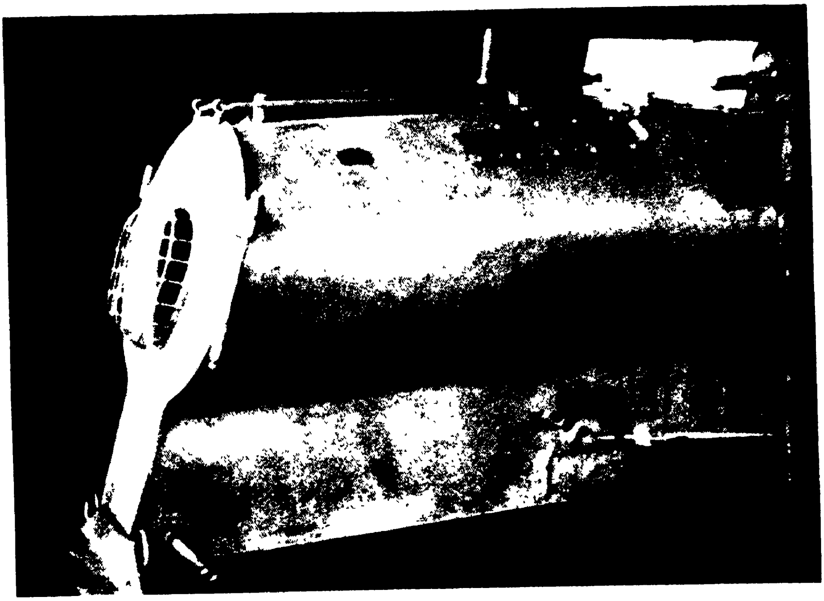

FIG. 1. Edminson's spraying cabinet for treating sheep with dipping fluids under pressure. Exterior aspect.

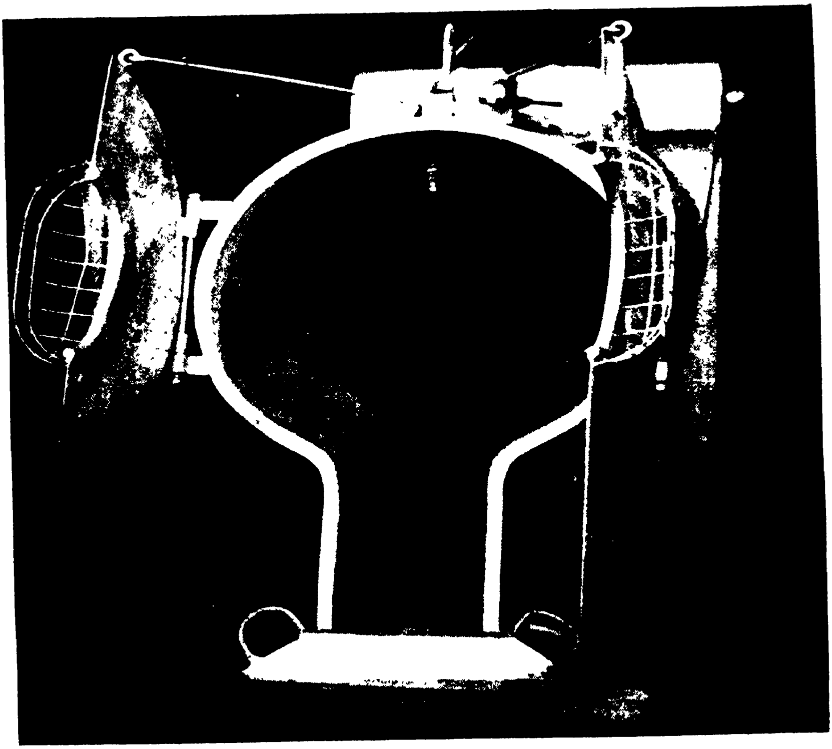

FIG. 2. Interior appearance of Edminson's spraying cabinet with the front opened by hand lever for egress of sheep.

It will be seen from the table that where sheep are dipped there is less strike, the difference between the two dips in this case being small. The chief trouble was with the scouring lambs.

Experiment II.—A flock of 600 sheep was divided into two groups. One group of 200 was treated with the oil emulsion dip and the other 400 with a proprietary arsenical dip. The experiment lasted twenty-eight days, when the whole flock was redipped. Table III gives the number of strikes in each group in this period.

TABLE III

Oil Emulsion				Arsenical Dip			
No. of Strikes	Per cent	Number Scouring	Not Scouring	No. of Strikes	Per cent	Number Scouring	Not Scouring
9	4·5	9	0	46	11·5	32	14

In this experiment the number of strikes was effectively reduced, no strike being recorded on non-scouring sheep, while with the arsenical dip 14, or 3·5 per cent, clean sheep were struck.

Experiment III.—A flock of 500 hill sheep, none of which was scouring, was divided into two groups of 250 each; one group was dipped with oil emulsion and the other with arsenical dip. The weather during the period was showery, with bright warm periods.

In the oil emulsion group seven sheep were struck over a period of 35 days, the first strike being 21 days after dipping. Thirty-two sheep were struck in the arsenical group during the same period, the first strike being fourteen days after dipping.

Experiment IV.—Three hundred sheep out of a flock of 1,000 were dipped with oil emulsion and the rest with arsenical dip. The flock was scouring very badly and was also affected with foot-rot.

The first strike in the arsenical group occurred 13 days after dipping, while in the oil emulsion group strike did not start till 13 days later, when strike became general in both groups.

It is rather surprising that any dip was effective under the conditions to which this flock was subjected, as the fields are situated in a shaded valley and all the lambs were scouring.

Experiment V.—Hand-spraying.—This experiment was done on a flock of sheep which had been dipped with an arsenical dip and strike had occurred every day after the fifth day from dipping. Of a flock of 200 sheep, 60 were sprayed with the oil emulsion dip, 60 with the proprietary arsenical dip, and 80 were left untreated.

The sprayer used was a horticultural hand instrument fitted with a hose and lance.

Great care was taken in treating the breech and the chest as strike takes place chiefly on these places.

Group I.—Oil Emulsion.—This group remained free from strike for twenty-eight days, and in a total of thirty-eight days 7 lambs were struck.

Group II.—Arsenical Spray.—The first strike took place in this group 20 days after spray and 16 lambs were struck in a total of thirty-eight days.

Group III.—Untreated.—Strike occurred every day in this group, and the owner insisted upon the whole number being treated. A total of 29 lambs were struck during fourteen days.

As the hand-spraying was so successful in this and some other minor experiments, the possibility of power-spraying was investigated.

In the first set of experiments Mr Edminson's power-spraying unit was used with jets placed all round a cabinet in which the sheep were placed, so that the sheep were treated with a fine spray which wetted the whole of the outside of fleece. This fine spray did not penetrate to the skin immediately, but in every case a 100 per cent kill of keds was recorded next day, showing that a slow capillary action took place which carried the fluid near to the skin within twenty-four hours.

Experiment VI.—The first power spraying experiment was carried out on 29th July 1935. Twenty sheep were sprayed with half a gallon each of the oil emulsion in 20 seconds, and were then taken to what is considered the worst fly-infested field on the farm, sheltered on three sides by a hedge, bounded on the other side by a river. The first strike was recorded four weeks after treatment when two cross lambs were struck. The other sheep on the farm, 350 in number, were dipped on the 26th July in the ordinary way with an arsenical dip, and some were struck two days after, strikes becoming very frequent seven days later.

Experiment VII.—Ten Blackface ewes and 10 cross lambs were selected and sprayed as in the previous experiment. In addition the lambs, all of which were scouring, were treated by means of a hand powder blower with a powder mixture consisting of diatomaceous earth 74%, flowers of sulphur 14%, finely ground paradichlorobenzene 10%, cresylic acid ½%, Whitcol J. ½%, gum arabic 1%. This powder contains a high percentage of fly repellents and adheres strongly to the dirty parts of the wool. All these sheep and lambs remained free from strike for 28 days. The rest of the sheep on the farm were dipped in the ordinary way and striking became common amongst them fourteen days after dipping.

The weather in both experiments VI and VII was bright and sunny, with intermittent rain.

In 1936 modifications were made to the spraying cabinet. New and larger jets were used and so arranged that the solution penetrated to the skin without wetting the whole of the outside of the fleece. The experiments in this case were not nearly so successful as when fine mist jets, which wetted the fleece, were used.

Experiment VIII.—An experiment was carried out at the

Rowett Research Institute upon three groups of lambs which were treated as follows:—

Group I—104 lambs sprayed with the new jets and using oil emulsion.
Group II—70 lambs dipped in oil emulsion dip.
Group III—132 lambs dipped in arsenical dip.

Over a period of one month the percentage of strike in each group was:—

Group I	7·5%
Group II	8·5%
Group III	10·6%

Many more experiments were carried out, but in some cases it was impossible to obtain exact data. In one district, where an elaborate experiment was laid out, no strike on any sheep was recorded for the first time for forty-eight years.

The general impression gained on so short an experimental period is that the oil emulsion is a definite advance on the water soluble dips, in that it is not so readily washed off by rain. For treating cases where wool-rot is the prime cause of strike it has definite advantages, and it appears that if properly applied it will greatly reduce the incidence of strike. Further work remains to be done, and more promising aspects of approach are now opening out from the experience gained by last season's work. The contamination of the dipping solution by fæces still remains a problem of ordinary dipping, and little progress can be made until this is overcome.

(3) **Blowfly Dressing.**—The search for an effective dressing for a sheep that has been struck by the fly was an important part of the investigation. Since it is almost impossible to obtain complete prevention of strike, a certain number of sheep will always require treatment for maggot infestation.

A "Blowfly Dressing" must:—

(*a*) Either kill the maggots or make them fall off the sheep.
(*b*) Cause the wound to heal up rapidly.
(*c*) Repel further attacks of the fly.
(*d*) Be easily applied.
(*e*) Avoid staining or lifting the wool.
(*f*) Be cheap.

The usual treatment for a maggot infestation is to apply sheep dip of double or even greater strength. There is great danger in this practice, as dip at this strength burns the skin, causing scab formation, and lifts the wool. Where an arsenical dip is used there is the additional danger of absorption of the poison by the open wound, resulting in the death of the sheep.

Early experimental work was confined to trying the effectiveness of existing treatments, but none proved satisfactory. While some of the substances used promoted rapid healing of the wound, they had little effect on the maggots, and they were found not to possess any repellent properties against further strike following this series of experiments, work was directed to the building up of a preparation which would, as far as the limited data available allowed, meet the requirements of an ideal dressing. A dressing, finally compounded, which, on trial in the field was very effective, has the following formula:—

	Per cent
Water-white mineral oil, as specified for the sheep dip	71
Cresylic acid, water-white, 99% purity	4
Yorkshire wool grease	10
Paradichlorobenzene	5
Oleum picis (rectified)	10

The mineral oil, cresylic acid and wool grease are mixed together and warmed, with occasional stirring until the wool grease goes into solution. While the mixture is still warm the paradichlorobenzene is added with constant stirring until dissolved. The mixture is then allowed to cool and the *Oleum picis* added and stirred until thoroughly mixed.

This dressing has been tried very extensively during the last two years, and excellent results have been obtained from its use. It promotes rapid healing of a wound, is unfavourable to maggots, making them leave an infested area, and killing them in a few hours, and it repels further attacks of the fly.

For treating a maggot infestation, a ring of the liquid should first be drawn round the area. The liquid should then be applied to the centre, and rubbed in with the hand. One dressing is usually sufficient where the maggots are living in the wool, but wounded sheep require greater attention. The wound should be opened to allow drainage of pus and the dressing applied daily until a skin forms upon the surface. In 1936 over 1,000 sheep were treated with this dressing and, with the exception of 9 cases, restrike only occurred where bags of pus were present in the wounds. Many farmers reported that it was the most effective treatment they had tried, and two stated they found it an excellent dressing for rams' heads. Some cases were noted of a slight staining of the wool by the dressing, but this was confined to the Down breeds, and did not appear to occur in the mountain breeds. A very small amount of the wool was affected and all traces disappeared in a few weeks. The staining was due to traces of asphaltic compounds in the cresylic acid and did not occur when acid free from these compounds was used.

(4) **Foot-rot.**—This condition is one of the most frequent causes of body strike. The usual treatment for foot-rot is to walk the sheep through a trough containing 5% copper sulphate solution or a strong arsenical solution. These substances have many disadvantages, the chief of which are:—

(*a*) Copper sulphate solution makes the hoof very brittle, with the result that cracks develop, giving openings for further infection.

(*b*) As the solutions are allowed to stand in the foot-bath for some time, evaporation takes place and in most cases the bath is made up by adding water or fresh solution, resulting in the liquid becoming too strong or too weak for effective treatment.

(*c*) Where an arsenical solution is allowed to stand in an open bath there is always the danger of animals being poisoned by it.

(*d*) Foot-rot is associated with wet conditions, and these substances, being soluble in water, are washed off the hoof as soon as the animal returns to damp ground.

A treatment to be effective must persist for some time even under wet conditions, and the only way in which this can be achieved is by using a waterproof dressing. Tar ointments satisfy this condition, but they must be applied by hand, and where many cases occur this entails a large amount of labour. The cheapest method of application is by the foot-bath and an oily waterproof dressing has been prepared which can be applied in this way.

This dressing is made by dissolving four parts of ordinary creosote in 96 parts fuel oil. It is placed in a foot-bath and the sheep are walked through in the usual manner. The dressing is rather more expensive than copper sulphate or arsenical solutions, but the small amount used at each application costs very little, and it does not evaporate.

The oil serves two purposes, as a waterproofing agent and as a carrier for the antiseptic. To persist for some time the oil must have a fairly high boiling-point, and as there is little danger to the sheep from using crude oil, the cheapest oil on the market, fuel oil, is the most suitable for use. For the antiseptic, cost again is a most important consideration. Crude creosote is not only one of the most efficient antiseptics, but is also the cheapest, and when mixed with oil in the proportions stated has no ill effect on the feet of the sheep. The surplus dressing can be retained in a foot-bath for a considerable period without any loss from evaporation or fear that animals will drink it.

Three hundred sheep, among which foot-rot was the prime cause of strike, were treated with this dressing by walking them through a 20-foot foot-bath, and the treatment was repeated at weekly intervals for a month. The incidence of strike was reduced from 18% to below 2%, and the shepherd reported that, although after treatment the sheep were placed in a damp field, the hoof remained in a pliable and waterproof condition, traces of the oil being seen on it two to three days later. At the end of the period, with the exception of a few very severe cases, the foot-rot appeared to be completely cured.

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EARLY SCOTTISH AGRICULTURE

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THE earliest inhabitants of the country now called Scotland must have followed the hunting and fishing type of life, subsisting on the food provided around them by nature—wild animals, fish and shell-fish, edible berries, nuts, acorns, fruits and plants or parts of plants. Under such conditions only small groups of people could exist in wide areas, and even so they would be subject, in our uncertain climate, to sharp variations in their food supply, and would be constantly menaced by the threat of scarcity. Thus they lived in a comparatively low state of comfort and of culture, and their main upward move would be the partial domestication of the dog, the ox, the sheep, and the horse; while their manufactures would be confined to weapons of the chase and of war, to articles of personal clothing and adornment, and to a few rude kitchen utensils. Be it noted, however, that many of these artifacts were produced with much skill and taste.

The great step forward was the introduction of agriculture, for that meant the provision of food which could be stored through a much longer period than the products of the chase and in greater quantity than the natural fruits of the earth.

How, when, and where cultivation was first practised it is impossible to tell, but the probability is that it originated in Egypt or Mesopotamia where grasses such as barley or millet would be naturally stimulated to extraordinary growth by the periodic flooding of the flats near the rivers, and their grains would become big enough to be noticeable and be plucked for food. The collection and storage of seed and the sowing of it on specially selected and prepared plots of ground would be the next stage, and the advantages of cultivation would gradually emerge.

The possibility of thus increasing the food supply would soon result in an increase of population, and that in its turn would mean demand for a bigger supply of food and a consequent search for further suitable ground to be cultivated in order to produce it. In this way came a spread of peoples and a spread also of acquaintance with the new art.

It is not unlikely that the knowledge and practice of cultivation was introduced into Scotland by some of those daring navigators who first ventured out of Mediterranean waters into the Atlantic and eventually reached these shores. Whether that be so or not, antiquarians tell us they have discovered cultivated grain pickles associated with urns of the Neolithic or late Stone period, together with the stone saddle-querns for grinding the grain into meal; and that grains of wheat and barley or bere have been found in association with utensils of the Bronze Age and of the early Iron Age in districts as widely separated as East Lothian, Fife, Clydesdale, Moray, Caithness, and Shetland. A further indication of early cultivation is the finding of sickles and querns. Bronze sickles now in the National Museum of Antiquities in Edinburgh were dug up in the counties of Aberdeen, Inverness, and Perth; and two iron sickles were got in the course of excavations at Traprain Law in East Lothian. Querns of both saddle and rotatory types, being made of more durable material, persisted and have been discovered in many different parts of the country.

Actual vestiges of early cultivation left on the land itself must obviously be scarce. Centuries of tillage have inevitably tended to obliterate all traces in most districts. But some vestiges do exist.

The early grain-growers would naturally select for what must have been to begin with a sort of garden cultivation, the most suitable plots of ground they could find, and curiously enough these were not, as we might have expected, on the lower levels beside the rivers, but in open pasture areas on hill-slopes. For in those pre-historic times the low ground was mostly mere swamp. The only cultivable land sufficiently dry, and from which rain-water would run off naturally, was a hillside. Indeed it is definitely asserted that " in primitive times in Scotland the average height " for cultivation seems to have been in the neighbourhood of 800 " feet above Ordnance datum: and it is only within comparatively " recent times that these high altitudes have been abandoned in " preference for the valleys."[1]

Indeed as late as 1689 an English writer Morer, quoted by Graham, writes—" It is almost incredible how much of the " mountains they plough; while the declensions—I had almost " said precipices—are such that to my mind it puts 'em even to " greater difficulty to carry on their work than they need be at in " draining the valleys."

As has been said, the variety of agriculture practised by our ancestors in the Neolithic and Bronze Ages was probably that of garden cultivation. A likely patch of ground in a convenient situation would be dug or scratched with a wooden implement, and cropped until the yield began to fail; then a move would be made to fresh ground and the procedure repeated. The effects of manuring and crop rotation permitting the continued use of the same piece of ground were later discoveries. This constant shifting of areas of cultivation makes all the less likely the persistence of indications of these earliest efforts, and, according to the authorities already quoted,[1] the first really definite evidence of primitive field systems belongs to the Iron Age. This is the Celtic field system, characterised by the lynchet and the terrace.

A lynchet is the natural result of the cultivation of land on a steepish slope. To prevent the cultivated soil from being washed downhill, a strip is left untilled on the lower edge of the plot. This strip then becomes the natural receptacle for stones unearthed in the course of tillage, and wind and rain tend to add to its bulk by drifting soil towards it, so that by and by the strip becomes a ridge or bank. The plot of ground between one ridge and the next below it would vary in width according to the steepness of the slope: on a gentle slope it might reach about forty feet.

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[1] Kilbride-Jones and Crichton Mitchell—*Proc. Soc. of Antiq. of Scot.* 1933.

In the Celtic system these lynchets are arranged in one of two ways—either in long strips one above another along the natural contours of the hill and divided into rectangular areas; or in long strips at right angles to the contours, but also divided across like the others, the transverse division lines forming the lynchets.

Another method of retaining the cultivated soil in place on a hill slope was that of constructing a cultivation terrace. In this case the building of the retaining wall is the first step in the process; whereas in the case of the lynchet the wall grows up, as it were, undesigned, except for the leaving of a strip untilled.

According to the authorities above mentioned there has so far been discovered only one instance of the lynchet in Scotland, the group at Torwoodlee, near Galashiels, which they have examined in detail. Of terraces there are said to be twelve known examples in Scotland: in Peeblesshire at Kilbucho, Purves Hill, Romanno, Moat Wood, and Venlaw: in Midlothian on the south-eastern slope of Arthur Seat, just above Duddingston Loch—in which it may be remembered evidences have been noted of an early lake-dwelling: in Roxburgh at Calroust and Hounam Law: in Berwickshire at Hutton and at Primrose Hill near Duns: and there are probably others not yet identified. There are numerous examples of Celtic fields on the Downs, on Dartmoor, and in other parts of England.

The actual methods of cultivation used in those primitive times is largely a matter of conjecture. To begin with the plots were probably small and irregular in shape and would be tilled with a digging stick or a mattock with a hoe-like head of stone lashed to a wooden handle. There would be no furrows. The crop might be reaped with serrated flint flakes set in a wooden sickle. Indeed the earliest sickle is said to have been the jawbone of an ox or other animal with flints set in the teeth-holes. The plots would be abandoned as soon as the soil became exhausted. The grain was ground with the saddle-quern.

The next stage was probably marked by the introduction of the foot-plough, of which the *caschrom* is a sample. This implement was used in the Western Islands of Scotland until quite recent times—if indeed it is not still used occasionally in outlying parts. The *caschrom* consisted of a stout curved handle about five and a half feet long firmly attached at an angle of 120° to a footpiece nearly three feet long, the point of which was shod with a sharp iron head. From the right-hand side just at the junction of handle and footpiece an inset peg projected, and to this the worker applied the digging force with his foot. The force so applied drove the share into the ground obliquely, whereupon the operator pressed on the handle and levered up the sod, turning it over at the same time to the left. Then he took a step back, drove in the point again, and repeated the operation. In this way he made a more or less straight furrow the length of the plot, and so might " plough " about twice as much in a day as he could have dug with a spade.

But at least the use of this implement produced a furrow and therefore brought about the rectangular shaping of the field.

In such a way, according to the old statistical account of Eddrachyllis Parish, even down to the eighteenth century, the inhabitants made a shift to "rear some corn," spending "great "labour in clearing their little plots, many of which are no larger "than the floor of an ordinary room, by digging, turning out great "stones and grubbing up bushes and underwood."

A further advance was made when the draught plough was brought into use. This may have developed from the use of the forked branch of a tree, the longer fork being linked to the draught animal or human, the shorter being the share· drawn through the soil, and the shank being the handle held by the cultivator. This rude device might well have evolved into the two-ox plough.

The first rudimentary harness for a draught animal seems to have been the knotting to its tail of a rope of hair or withies which was attached to the implement—plough or harrow. The method was used as late as Saxon times in England and much later in parts of Scotland. The introduction of the yoke transferring the draught to the shoulders was a big advance.

In the earliest form of plough a metal point was simply fitted on to the wooden share without any device for turning over the soil. The implement merely made a groove in the soil with a slight upcast of earth on either side. Coulters are said to have been added in Roman times.

With the coming of the Saxons to England in the fifth and sixth centuries, Continental ideas and methods were introduced. As we have seen, the Celtic system of cultivation was confined to the hill slopes. The Saxons on the other hand settled in the valleys, and so were immediately faced with the necessity of draining. This need was met by the adoption of what is known as ridge-cultivation, which was really an application to level ground of the principles of slope cultivation. The valley farmer created a series of artificial slopes on the level ground by digging out the soil at one place and heaping it up at another, producing ridges and furrows. Evidences of ridge-cultivation are still numerous, and may be seen in all parts of the country, for the practice persisted until quite recent times.

The ridges as finally evolved were usually twenty to thirty feet wide and about three feet high from furrow to crown. Their length varied greatly according to the space available, but one may put it that it was as long as possible, so as to avoid turning; for in the early stages of ploughing with heavy wooden implements, imperfect yoking, and teams of animals not easily controlled, turning was a difficult job. The same drawbacks probably accounted for another feature of these old ridges which one cannot help noticing—their curious curving direction. They are never drawn straight, but always in a sort of lazy serpentine bend. One explanation given for this is that the man who guided the oxen or horse team had difficulty in preventing them from turning before the end of the furrow was reached, and, as the custom was for the plough to be turned to the right-about, he would keep heading his team to the left, and, overdoing this, produced the curving sweep of ridge and furrow which was apparently so common. More probably, perhaps, the furrow was bent to prevent too rapid a run of water after heavy rain, which would have washed away the soil.

However that may be, the Saxon system made a definite breakaway from the Celtic tradition. They cultivated the lower ground, they introduced eight-ox ploughs, their furrows were therefore drawn much longer, and their fields developed the long strip shape which became so common in England in Mediæval times. Their methods spread into Southern Scotland where the " twal owsen " plough was in use even as late as the beginning of the eighteenth century. The great clumsy wooden plough was dragged at the end of a long iron chain by the twelve oxen yoked in pairs, or three or four abreast, led by one man walking backwards and driven by another, the gadsman—coming behind with his long goad, while the ploughman held the stilts, and another man with a spade " mended the land " and filled up the hollows. In this laborious fashion about half an acre a day might be ploughed, and very badly ploughed at that.[1]

Harrowing may have developed from the covering of the seed by simply drawing the branch of a tree over the seed bed; when heavier soils came under cultivation the clods had to be dealt with by a weightier implement, and the wooden frame with wooden teeth would be invented.

While harvesting probably began with simple plucking of the ears or pulling up of the plant by hand, yet progress must have been early, for, as we have noted, our Bronze Age ancestors had their reaping implement, the sickle, toothed or smooth-edged; and that implement, when fields became larger and harvests heavier to reap, readily suggested the bigger and more powerful scythe, without actually being itself entirely displaced.

The grinding of corn for food was first done by simple knocking between two stones, just as acorns and beech-nuts had been treated before corn was known to the early Briton. From that the transition to rubbing was easy, and the quern, first saddle and then rotatory, became universal; and the later stage, the upper and the nether millstones moved by animal or water or wind power, was an inevitable evolution.

Before grinding, the grain might be dried beside the fire or on a slab over it, and from that to the idea of a special kiln was but a step. But one primitive method of treating the grain long survived in the Outer Hebrides and is described by the eighteenth-century traveller, Martin. Some straw was set on fire and a bunch of ears was held in the flame till the husks were scorched. Then the grain was beaten out and ground in the quern, the resulting meal being known as *graddan*.

When written records first came to be made the writers occasionally alluded to food production. Thus Adamnan's *Life of*

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[1] For an account of this old plough and its working in Aberdeenshire see an article by Professor J. A. Scott Watson in this JOURNAL, vol. viii, p. 359 (1925), in which the *cas-chrom* is also described. The eight-ox team and other plough teams are discussed in a further article by the same writer, vol. xiv, p. 140 (1931).

Columba speaks of milk being carried from the fold, and tells of the raising and the grinding of corn in Iona: and Roman writers note that at the time of the Roman Invasion there were in Britain, besides hunters and herdsmen, tribes who tilled the soil, kept flocks and herds, and lived in villages for common defence. The systems of land tenure and of farming practice which developed under these early conditions cannot be determined with any degree of accuracy, but it is not unlikely that tribal ownership may have been usual in many parts of Scotland. The land was the property of the clan, and each clansman had a right to live on and by it. The affairs of the community were discussed and settled in the clan gathering or *mod*, in which each man had a vote. But the gathering was presided over by the chief; his personality and influence would predominate, and so in time the lesser tribesmen would come to look on him as their protector. To secure his favour and to foster his dignity as head of the clan they would bring him good-will offerings, but these would come in time to be regarded as customary rights of the chief and quasi-burdens on the clansmen—a kind of rental due by them for the portions of the tribal land they occupied. This burden came to be known as *cean*, or *cean muth*, and later as *kain*.

Some such development of land tenure, varying doubtless in detail in different places, probably prevailed over the greater part of Scotland until Norman influence in the time of Malcolm Canmore and his successors gradually introduced the feudal system of tenure. Fundamentally that system depended on the theory that all the land belonged to the king and that he shared out portions to his barons in recompense for services to be rendered by them to him in peace and in war. The great barons in turn gave possession of parts of their holdings of land to the lesser barons on similar terms. The holder of land under a feudal charter was accordingly in a sense the personal servant of the superior who retained ownership of the land even although he had granted the use and occupation of it to his tenant; and the personal quality of this relationship was emphasised in certain ways. Thus the superior was not obliged to accept the vassal's heir as successor in the feu, and so could claim a fine on entry of the heir as the price of his acceptance. So also the marriage of the vassal required the lord's consent.

These and other burdens of feudal tenure were new to the old customary land-holders in Scotland, and they were unwelcome to the great heads of clans who were reluctant to come under the yoke by accepting charters from the king. Much of the unrest of the fourteenth and fifteen centuries was due to the struggles between king and nobles over this question of superiority.

Under feudal practice the *inland*—the part of the lord's land nearest his fortalice—was tilled by serfs: the *outlands* were let to tenants in return for services in peace and war. The serfs were bound to the soil—*adscripti glebæ*—they were the property of the lord and passed from one master to another when an estate changed hands. The tenants of the outlands were as a rule freemen, but they were obliged to pay as rent some portion of the produce of their labour, and in addition to render customary services as determined in the baron's court or settled by understanding with the tenant.

How the serfs came eventually to achieve their freedom is not quite clear. Many of them doubtless took advantage of the opportunity offered by what was known as *steelbow* tenure to become tenants. In that arrangement the lord let both land and stocking to the tenant, who undertook to carry out the obligations of the let during its run and to return to the lord at its issue live stock and other equipment of the holding not less in amount than or inferior in quality to that which he received on entry. Steelbow tenure was common in Scotland in the fourteenth and fifteenth centuries and while it was not favourable to improvement of land or of stock, nevertheless it did give to the poor labouring man the chance to make a living on the land, and in this way his condition gradually became similar to that of the free tenant. But naturally many of the serfs continued to be merely land labourers.

Both classes of tenants had to pay rent and both had certain services to render according to the terms of their contract or according to the customs of the district. We may get some idea of the nature of such services by taking a case quoted by Cosmo Innes from the Register of the Abbey of Kelso. In their barony of Bolden the monks of Kelso had twenty-eight husbandlands. Each tenant of these holdings had to pay a yearly money rent of six shillings and eightpence and was obliged in addition to render these services:—

> Four days reaping in harvest, the husbandman with his wife and all their family, and a fifth day the husbandman with two other men.
>
> One day carting peats from Gordon to the Pullis, and one cart-load yearly from the Pullis to the Abbey.
>
> The service of a man and horse to and from Berwick once a year, the monastery to feed them.
>
> To till an acre and a half, and to give a day's harrowing with one horse yearly.
>
> To find a man for the sheep-washing and one for the shearing, the monastery to feed them.
>
> To serve with a wagon one day yearly to bring home the harvest.
>
> To carry the Abbot's wool from their barony to the Abbey, and to find carriage over the moor to Lesmahagow.

Besides such services as these there would in most instances be exacted customary tributes like *herezeld*, or *heriot*—the best beast on the holding claimed by the lord on the death of a tenant: *thirlage*—an obligation by the tenant to pay for the grinding of his corn at the lord's mill, and that whether it was ground there or not: and other lesser burdens.

It is obvious that these exactions were bound to be often inconvenient and sometimes even galling to tenants, but their chief importance, historically regarded, lies in the fact that they were specific. They defined the limits of the husbandman's liability to his lord, and therefore they established his freedom in respect of the rest of his activity.

In course of time services were commuted to money payments, and the husbandmen were freed from their former state of quasi-servitude. Thus a real revolution took place without either popular uprising or State intervention, but merely through pressure of economic conditions.

It would of course be only in the later stages of the development of the feudal system that the dues to be paid by tenant to lord would be so definite. To begin with, presumably, the rights of the lord and the liabilities of the vassal would be indefinite and might vary from holding to holding. But custom would gradually develop a general practice and the services to be given would tend to become determined more and more specifically, and eventually to be set down in writing. As we might expect, written leases were introduced by the monks, and they first appear about the end of the twelfth century. They were originally of the nature of charters, writs signed only by the granter, assigning to the tenant the use of the holding for a certain term and on the conditions set forth. Later, leases became bi-lateral contracts, signed by both landlord and tenant, each binding himself to fulfil certain conditions.

In this connection an Act of the Scots Parliament of King James II. in 1449 was important. Under the caption—*The Buyer of landes suld keepe the Tackes set before the Bying,* "it is "ordained for the safety and favour of the puir people that labours "the grund that they and all utheris that hes taken or sall take "landes in time to come fra lordes and hes termes and yeires "thereof, that suppose the lordes sell or annaly that land or landes, "the takers sall remain with their tackes unto the ischew of their "terms, quhais lands whatever they lands cum to, for siclike maill "as they took them for."

In other words, leases were made secure to their holders on the original terms up to the end of the lease, and that against any superior into whose hands the property of the land might come.

Ancient leases were for very varied terms, for any period from three to thirty years or more, for a lifetime, or for the duration of joint lives, even for "as long as girss grows and watter rins." But by-and-bye nineteen years came to be regarded as an equitable period, giving the tenant a chance of averaging out over good, bad, and indifferent years.

Throughout the Middle Ages progress in agriculture was slow. Means of communication were non-existent and new ideas took a long time to spread. But the biggest hindrance to improvement is to be found in the character of the Mediæval system itself. Picture a community as it existed in Stuart times. For the sake of mutual protection the farmers grouped together into a village. Their lands lay round it and were held and cultivated in common on the run-rig plan: the in-field was cropped continuously in a three-year rotation, first Bere, second Oats, third Awal Oats, and getting whatever manure was available: the outfield was manured only by the pasturing of cattle on it, and portions of it were cropped in oats for as many seasons as they could be got to yield as much as three times or even twice the amount of seed sown, after which they were allowed to tumble down to grass and weeds and to lie fallow for some years until their turn came round again for cropping.

All the cattle from each man's holding were gathered together and driven daily by the village herd to graze on the common field or moor where they might pick a meagre sustenance. The only use made of more distant hill pastures was to send the cattle there in summer. It was the custom in many parts of the country for the families of the farmers to transfer themselves yearly with the cows, sheep, and poultry to the hill shielings. There they lived a kind of idyllic life for two or three months during the summer, and laid up stores of butter and cheese, of yarn spun and garments woven by the women and brogues and tools made by the men, and of peats and fir-splints for heat and light in the winter. This practice continued in some places until well on in the nineteenth century, and traces of the old shielings in which the families sheltered may still be seen in many a Highland glen or upland. What really brought this practice to an end was the spread of the Blackface breed of sheep which began about the latter part of the eighteenth century. The older small gray-faced native sheep were grazed on comparatively low ground and were even housed at night, partly no doubt for protection against wild animals and reivers, but also because it was believed that they could not stand the exposure to the severity of wintry conditions. When accident proved that the hardier breed could withstand the weather and thrive, there was a quick resort to the higher pastures; other breeds as well as the Blackface came to be wintered out, and hill-farming as we know it came into being.

Hence the Lament of Duncan Ban MacIntyre:—

> " I'll fa' the sheep, a gray-faced nation
> " That swept our hills with desolation;
> " The gray-faced sheep that worked our woe
> " Where men no more may reap or sow;
> " The good gray mare no more is seen
> " With its frisking foal on the open green,
> " And I seek in vain for the cow that lay
> " Licking its calf on the bonnie green brae;
> " And the bonnie milkmaids—ohone, ohone,
> " Are seen no more when the kine are gone,
> " And there's now no work for the lads to do
> " But to herd the sheep—some one or two."

Incidental mention of raiders reminds us that all through Stuart times the state of the country was such that progress in agriculture was virtually impossible. It was a time when he might take who had the power and he might keep who could. In the Complaynt of Scotland published at St. Andrews in 1548 the condition of the peasantry is described thus—" My cows and my " cattle are reift frae me. . . . There is naething on labourers of " the grund but arage[1] and carage,[2] taxations, violent spulzie,[3] and " all sorts of adversitie."

In 1585 Lord Binning in his Complaint to King James VI. relates that " in all parts of the countrie there were treasons, " murthours, burnings, thefts, reiffs, herschips,[4] houghing of horses " and oxen, breaking of milnes and ploughs, destroying of corn, " and all sorts of barbarities, no place or person being exemed or " inviolable."

The years of the long controversies in religious matters were alike inimical to improvement.

Throughout these stormy times Border reivers and Highland caterans were active, and cattle forays and creaghs were common. If a douce laird or farmer near the Highland border wanted to be left in peaceful occupation of his holding or to keep possession of his crop or live stock, his best plan was to pay insurance in the shape of blackmail to some chieftain who would undertake not to raid the holding himself and would guarantee that he would keep other lawless clansmen from doing so. In the Old Statistical Account of Killearn an example is given of an undertaking by the Grahams of Glengyle to protect from being lifted the cattle of the gentlemen and heritors and tenants of Perth, Stirling and Dumbarton named in the attesting clause, in return for payment of a percentage of their rental. The contract is dated in 1741 and is said to have been faithfully observed and carried out.

Little wonder is it that under the conditions described the general state of agriculture in the country was pitiable. There was an entire lack of proper drainage: field enclosures were scarce: cultivation with the wretched implements available was poor and ineffective, resulting in insufficient aeration of the soil: there was a great deficiency of manure: and the quality of seeds sown was bad. Live stock was miserable in kind and was half-starved in winter for want of fodder, or knowledge of how to provide it.

Not indeed until the post-Union period did Scottish farming begin to rise from the low level of performance that characterized it throughout Stuart times.

[1] Servitude of men and horses for ploughing to the landlord.
[2] Similar service of carrying loads for the landlord.
[3] Plundering raids.
[4] Plunderings.

THE IMPROVEMENT OF GRASS LAND BY PLOUGHING UP AND SOWING OUT DIRECT

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MANY farmers nowadays give much attention to their pasture land, and by dint of manuring, the use of approved seed mixtures and good management, have greatly improved much of the grazing land in Scotland. As a result such land now carries not only a greater head of stock, but nourishes much better the stock that it does carry. There are still, however, extensive areas which could be greatly improved.

But attempts at improving grass lands have frequently yielded only disappointing results. In many cases the application of phosphatic and potassic manures have effected only a very slight betterment. This often happens where there is a " mat " on the surface of the soil and where there are few, if any, really useful grazing plants in the herbage. Under such conditions the plough is very obviously indicated as the first step in the process of improvement. In other cases, rotation pastures, very soon after being sown down, deteriorate into wiry, innutritious, worthless herbage. This results most frequently from a deficiency of phosphate, of lime, and to a lesser extent, of potash. In the issue of this JOURNAL for October 1929 the writer quoted such a case, where of the ingredients sown the only species found in the pasture four years afterwards were Perennial Ryegrass and Hard Fescue and where the herbage consisted chiefly of Bent, Sweet Vernal and weeds such as Sheep's Sorrel.

In the issue of the JOURNAL for April of this year an account is given of improvements carried out on two areas in the north of Scotland.

The West of Scotland Agricultural College transferred its farming activities from Kilmarnock to Auchincruive, Ayr, at Whitsunday 1931. This article will be devoted chiefly to giving an account of the procedure adopted at Auchincruive, where two fields—the Calf Park and the Mansion House field—were ploughed up and sown down without a nurse crop and without having been put through a rotation of cropping. The ploughing of both fields was carried out in the months of December and January. In the former case a single-furrow tractor-drawn Oliver plough was used, and in the latter case a Begg plough. The aim was to plough about 10 inches deep, but this was not always attained on the Mansion House field owing to the nature of the soil. In some parts of this field the ploughing was only 7 or 8 inches deep. In April the ground received a considerable amount of cultivation with ordinary and disc harrows in order to produce a tilth for the seeds, care being taken not to bring to the surface sods or pieces of the furrow.

With the object of incorporating the lime and artificial manures thoroughly in the surface soil, these were applied before the final harrowings. A turn with the Cambridge roller was then given in order to obtain a firm seed-bed. After the grass seeds were sown, one turn of light harrows was given and the land rolled with the ordinary roller.

The Calf Park.—This is a small field of 4 acres, well sheltered, in close proximity to the farm steading, and therefore a "handy" field into which to turn calves or a newly-calved cow. Prior to the treatment about to be described, the field was almost an eyesore with its worn-out, weedy appearance. The cultivations and seeding already mentioned were carried out in the spring of 1934. Ground limestone was applied at the rate of 15 cwt. per acre, and also the following mixture of artificials:—½ cwt. sulphate of ammonia, 1 cwt. superphosphate, 2½ cwt. steamed bone flour, 1 cwt. muriate of potash. The grass seeds were sown on 23rd April. A vigorous braird ensued and by nine weeks young cattle had to be turned on to graze. From this time (about the end of June) till the end of October a luscious growth of excellent pasture was obtained. Because of the varying ages of the calves and young stock and because some sheep were also put on, it is difficult to state precisely the stock carried, but reduced to a cow basis it works out approximately to 65 cow weeks—the supporting of 4 cows for 16 weeks, July to October inclusive; on a sheep basis it is equivalent to 650 sheep weeks. If the value of this is put at 4d. per sheep per week (a moderate figure for the excellent young herbage), this would give a return of £10, 17s. In 1935 the stock carried was equivalent to 118 cow weeks or the equivalent to grazing nearly 5 cows for a season of 24 weeks, or 1,186 sheep weeks, which at 4d. per week equals £19, 15s. In 1936 the stock carried was equivalent to 100 cow weeks or the equivalent of 4 cows for the grazing season. No artificial manure has been applied since sowing out. Two seed mixtures were used, the details of which are given in the table which follows, as well as a botanical analysis of the herbage made in June 1937. In mixture A, 12 lb. Meadow Fescue and 5 lb. Meadow Foxtail were included, while in B 7 lb. Cocksfoot and 4 lb. Timothy were substituted for these. Otherwise the ingredients were the same. So far, no marked differences between the mixtures have been observed:—

Name of Plant	Seed Mixtures		Botanical Composition June 1937	
	A lb.	B lb.	A per cent	B per cent
Perennial Ryegrass	6	6	31	34
Evergreen Ryegrass	6	6		
Italian Ryegrass	4	4	...	1
Meadow Fescue	12	...	12	2
Meadow Foxtail	5	...	2	1
Cocksfoot	...	7	2	6
Timothy	...	4	...	7
Rough Stalked Meadow Grass	1¼	1¼	17	14

Name of Plant	Seed Mixtures		Botanical Composition June 1937	
	A	B	A	B
	lb.	lb.	per cent	per cent
Broad Leaved Red Clover	1	1	...	...
Dorset Marl Red Clover	2	2	...	...
Alsyke Clover	1½	1½	...	...
Wild White Clover	¾	¾	18	18
Yorkshire Fog	...	...	9	8
Bent	...	...	1	1
Buttercup	...	...	7	5
Daisy	...	...	...	1
Sweet Vernal	...	...	...	1
Miscellaneous	...	...	...	1

Both mixtures have given excellent results and three years after being sown down the field is remarkably free from weeds and inferior plants. Meadow Foxtail has made little headway, although it grows naturally in the adjacent hedgerows. Meadow Fescue occupies 12 per cent of the herbage in A, while Cocksfoot and Timothy combined contribute 13 per cent in B.

The cost of all the cultural operations—ploughing, harrowing, disc harrowing, sowing manure and seeds, and including a few miscellaneous operations, such as digging out some old tree stumps, amounted to £2, 14s. per acre. The ploughing up and sowing down of this paddock direct has been amply justified. As already indicated, had it been put through a full rotation of crops, the grazing facilities provided for calves and miscellaneous stock would have been badly missed.

Mansion House Field.—This was part of the policy ground when Auchincruive was a private residence, and it had not been under the plough in the memory of any living person. Like most such policy grounds, it was studded with trees. The herbage was of a very inferior type, consisting for the most part of Bent and Sheep's Fescue and infested with Buttercup and other weeds. The soil is variable, but most of it may be classed as a light loam. As the intention was to make this the main grazing for the dairy herd, it was decided to uproot a considerable number of the trees and this was effected soon after the College came into possession, between 60 and 70 trees being removed. There still remain growing in this 48-acre field some 50 trees which undoubtedly add to the picturesqueness of Auchincruive, but which can hardly be regarded as an asset in the establishment of good pasture. As there was some reluctance to plough up this old policy field, an effort was made to improve the grazing by manuring, and in the years 1930 to 1935 the following total quantities were applied per acre:— 8 cwt. potassic mineral phosphate, 35 cwt. shell lime, 10 cwt. basic slag, 3 cwt. potash manure salts.

In 1932 the field was divided into six enclosures and rotational grazing was practised, while in three of the five years referred to, heavy dressings of nitrogenous manures were also applied. There was some response to this manurial treatment. Wild White Clover made its appearance, the herbage lost something of its dry, wiry nature and became more succulent, but the grazing season was short and from about the beginning of August liberal feeding with concentrates had to be adopted to maintain the milk yield. Severe harrowing and the sowing of a renovating mixture of grass and clover was tried on a part of the field, but with little benefit. In 1935, five years after the first treatment was given, the grazing was still far from satisfactory. It was decided to plough 18 acres and this was done in the winter of 1935-36. Owing to the ramifications of tree roots and old stone drains now almost at the surface, the task of ploughing was not an easy one. It was accomplished by a single-furrow tractor-drawn Begg plough.

In the spring after a tilth had been obtained the following manures were applied per acre:—15 cwt. ground limestone, 1 cwt. Chilean potash nitrate, 2½ cwt. steamed bone flour, 1½ cwt. superphosphate, 1 cwt. muriate of potash. Four seed mixtures were employed designed to test such questions as the use of leafy strains of grasses against ordinary commercial strains. As this grazing land was needed for the farm stock at the earliest possible moment, 10 lb. per acre of Italian Ryegrass was included. This grass is pre-eminent in its ability to establish itself quickly, and where, as in this case, the land is to be grazed the first year (not hayed) it has not the opportunity of depressing the growth of slower maturing grasses and clover. The grass seeds were sown on 23rd April 1936. The cost of all the cultural operations amounted to £2, 12s. per acre.

At first the seeds did not make so rapid headway as in the case of the Calf Park two years earlier. This was probably due to a rather dry month of May. The growth in the areas seeded with commercial strains was noticeably more vigorous than where seeded with Evergreen leafy strains. However, with rains in June and the higher temperature prevailing, growth became rapid and dairy cattle and sheep were turned on in the first week of July. So rapid was growth at this stage that the stock could hardly cope with it and it was felt that perhaps the stocking should have taken place a week earlier. From this date till the middle of November milk cows and sheep grazed it daily and the area yielded a wealth of nourishing herbage. Records as to the actual stock carried on this re-seeded area could not be obtained, as there was no water supply and access to the untreated portion of this field had to be maintained. Records show, however, that the whole field (ploughed and unploughed) carried in 1936, for a period of 24 weeks, the equivalent of 8 cows more than in 1935, and this despite the fact that the re-seeded area of 18 acres was unstocked from the time of ploughing in January till the first week in July. This higher stock-carrying capacity may reasonably be attributed to the greater production on this renewed portion. But the extra head of stock carried does not reflect by any means the full measure of improvement, because the herbage on the re-seeded portion all through the summer and autumn consisted of excellent nutritious material, while that on the unploughed area from August onwards would contribute little or nothing as a production ration.

Other 18 acres of the Mansion House field were ploughed in the winter 1936-37 and sown out on similar lines to those followed in 1936. That leaves only 12 acres at the top of the field and nearest to the farm steading as old pasture. This area of 12 acres, plus the 18 acres sown down in 1936, carried from 1st April to 5th June 1937 an average stock of 39 ewes with their lambs, and from 1st May to 5th June 60 Ayrshire cows. In spite of this fairly heavy stocking, it looks at the time of writing (15th June) as if the mower would have to be put over it to prevent the Ryegrasses running to seed. Again, in this case, it would seem that ploughing out and sowing down direct has been amply justified.

General.—During the last twelve or fourteen years, we have had the privilege on several farms of mapping out and directing the procedure of renewing worn-out grass land. Wherever it seemed impracticable for economic or other reasons to put such land through the ordinary rotation of the district, we have never hesitated to recommend ploughing up and sowing down direct, rather than attempting improvement by manuring only, and in every case excellent results have followed. Degenerate pasture consists of a sward of wiry, weedy herbage, which for six or seven months in the year has that whitish-brown or winter-burned appearance indicative of an unpalatable innutritious condition. This results from a deficiency of some or all of lime, phosphate and potash, but it is obviously quite impossible to produce a productive succulent pasture by the application of liberal quantities of these ingredients, because the productive succulent plants capable of responding to such treatment are not present. The sure remedy is to bury the poor herbage by ploughing, give the necessary cultivations to produce a tilth, apply the necessary manurial ingredients, and sow a suitable grass-seed mixture. Ploughing without supplementing with manures on an impoverished soil is even more futile than manuring without ploughing. The two things should go hand in hand. Phosphate is the most essential manurial ingredient in the establishment of good pasture. In all cases where land is being sown down we suggest that an application of at least 4 cwt. steamed bone flour or ground mineral phosphate or about double that quantity of slag should be applied per acre, but much larger quantities will often be profitable. We saw a field recently where 16 cwt. per acre of ground mineral phosphate resulted in a much better sward than where 8 cwt. were applied. Likewise, about 1 cwt. muriate of potash or 2 cwt. potash manure salts should be given. On very light soils and on peat these quantities of potash may very well be doubled.

Lime is almost invariably deficient where a " mat " or layer of undecomposed vegetation has accumulated on the surface of grassland and where Bent and wiry grass and Sheep's Sorrel are abundant. If a farmer is in doubt as to the need of lime, he should consult the County Organiser. The lime requirement can be fairly accurately determined by having samples of the soil tested. Should such analyses reveal a heavy lime requirement, say several tons per acre, and if the cost of such a heavy dressing is considered prohibitive, then it should be remembered that the application of a less quantity is still worth while. Half a loaf is better than no bread. It is our experience that lime is never more effective than when applied on the top of the ploughed land and harrowed in just before the grass seeds are sown. Applied thus, a considerably less quantity than the full lime requirement seems to sweeten the upper layer of soil sufficiently to enable the productive grasses and clovers to establish themselves. Let it be emphasized that lime is more essential for the establishment of the big productive grasses such as Cocksfoot, Timothy, Meadow and Tall Fescue and the Ryegrasses than for Wild White Clover. There is one other point that should be stressed. All the manures—lime, phosphates and potash—should be applied and harrowed in before sowing the grass seeds, rather than giving a light dressing at this stage and then applying some more say the following year.

The essential points in improving worn-out grass land by ploughing and re-seeding direct, may be summarised as follows:—

(*a*) The pastures should be well grazed down the previous summer and autumn, using the mower if necessary. The less herbage there is to bury, the more easily will the ploughing be accomplished.

(*b*) Ploughing is best done between Martinmas and February. If ploughed earlier than Martinmas there is always some risk that with open weather some of the turned-down herbage plants may show growth amongst the furrows. Further, early winter frosts and the more moist condition of the soil during mid winter, make the tough upper layers more amenable to the plough; ploughmen put a good deal of stress on this advantage in the case of tough lea land. On the other hand, if the ploughing is not accomplished by February, then there is less chance of benefiting from the weathering effect of frosts on the upturned furrow slice, which is a great aid to securing a tilth. Whatever the method of ploughing, the turf must be completely buried—not showing between the furrows.

(*c*) When the land has dried out sufficiently in the spring, shallow cultivations should be given to secure a seed bed. Such cultivations should not be deep enough to bring up sods or whole pieces of the furrow slice.

(*d*) Manures and lime should be applied before the final harrowings are overtaken because these help to incorporate them thoroughly in the surface soil. Liberal applications of phosphates should be given and lime should not be withheld where the need for that is indicated. In addition to the manuring already referred to, it is beneficial to apply a small quantity of quick-acting manure—up to 1 cwt.—of a nitrogenous manure and 1-2 cwt. superphosphate per acre. This to stimulate rapid growth in the early stages and thus enable the newly sown pasture plants to give a quick cover and so suppress weeds.

(*e*) Some stirring up of the soil should be done *immediately prior* to sowing the grass seeds, so that no vegetation may start with a handicap over the young seeds.

(*f*) The seeds should not be sown too early in the season—not until the temperature is such that germination and growth will be fairly rapid. Otherwise certain weeds may outgrow the young grass and clover seeds. We suggest that the time of sowing should be between 20th April and the end of June

(*g*) A determining factor to success, but outwith the control of the farmer, is a sufficiency of moisture in the soil for germination and to keep the young seedlings growing rapidly in the early stages. A prolonged dry barren spell of weather about the time the seedlings are coming through the ground may kill off a considerable proportion and a disappointing take of grass may result.

(*h*) Although it was not done at Auchincruive, it is beneficial to run the mower over the field when the braird is 5 or 6 inches high. The knives should not be set too close to the ground. This mowing helps to check unsightly weeds such as Dead Nettle, Charlock, etc., which may have come up. Further, it delays, by perhaps ten days, the time when stock have to be turned on and this enables the young plants' rooting systems to become better developed. The cuttings should simply be left on the surface to shrivel up. We even think this encourages tillering and ensures a closer sward. Stock should then be turned on sufficiently soon and in sufficient numbers to keep the herbage in control. If it is allowed to get too rank, the slower-maturing plants suffer from the agressive ones. The ideal is perhaps rotational grazing—stocking heavily for a time and then resting for a week or two. Finally not much grazing should be done after the end of October during the first winter. The rooting systems are not yet fully developed and the plants will suffer by too close depasturing.

The extra cost of this method of improving grass land compared with that of manuring only, comprises the costs of cultivation and of the seed mixture. The former at Auchincruive, as already indicated, was heavy owing to the special difficulty of tree roots in the old policy field. In a normal case we think 30s. to 40s. per acre should cover it. A like figure should meet the cost of the seeds. We thus arrive at a total for ploughing and seeding of from £3 to £4 per acre. We have little doubt that this cost is more than recovered in the improved quality and quantity of the grazing during the first two seasons—the year of seeding and the following one.

Let it be made quite clear, that while, in this article, we have been stressing, in the case of permanent pastures of poor quality, the possibilities of improvement by ploughing and sowing down direct, we are not advocating such procedure as preferable to putting land through a rotation of crops and thoroughly cleaning it, before sowing out. Even in the light of all the many recent advances of science, we know of nothing that is likely to prove a a better forerunner to a first-class pasture, than the growing of a robust green crop—potatoes, turnips, marrow-stem kale, etc. The thorough cultivation of the land—the application of farmyard manure and of liberal dressings of phosphates—the suppression of all weed growth, which are the usual concomitants of such crops, all tend to bring the soil into the proper condition—physically, chemically and biologically—for the healthy vigorous growth of young grass and clover plants.

THE EFFECTS OF LIME ON THE SOIL

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From very early times the farmer has realised the value of applying regular dressings of lime to the land. Until towards the end of the nineteenth century it was the practice to apply liberal dressings, but when labour costs rose and artificial manures began to be used, smaller dressings became customary. When the farmer decides to lime, he wishes, of course, to do so as economically as possible. It is, therefore, desirable that he should know the extent of the need for liming, how much lime should be added and for how long its effects will last. The need of a soil for lime is not a matter that can be satisfactorily determined by mere inspection in the field. It is often wrongly assumed that a simple effervesence test with acid will determine whether or not the soil needs liming. It is true that effervesence usually denotes a satisfactory condition, due to the presence of free lime. A negative result does not mean, however, that the soil is necessarily lime-deficient, and such a test may thus prove misleading. The distinction must be made between the lime as applied, and the lime after it has entered into combination with the soil. The lime in either form can be utilised as required by the plant, but the combined lime is much the more resistant to loss by drainage. A laboratory examination of the soil can tell us satisfactorily how much lime is present, and how much should be added if there is a deficiency. The undesirable qualities of lime-deficient soils are due mainly to acid taking the place of lime. Lime is being removed continually by the drainage water and to a smaller extent by the crop. The soil becomes progressively more acid, and if the shortage of lime is not made good, the general soil conditions may become so unsatisfactory that crop failure results.

Degree of Acidity.—It is desirable to have some numerical method of describing the acid condition of the soil. This can be done by means of what is known as the pH scale[1], in which the values range from 1 to 14. The neutral point on this scale is 7. A figure less than 7 points to an acid condition of the soil, and one greater than 7 to an alkaline condition. As applied to soils only a small section of the scale is used, and a rough classification would be:—

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[1] An acid condition of the soil is due to hydrogen taking the place of calcium and other bases. The acidity can be measured as the amount of hydrogen ion or active hydrogen. At the neutral point, for example, the concentration of hydrogen is $\frac{1}{10,000,000}$ gramme per litre. This fraction can be written as $\frac{1}{10^7}$, where 10^7 means 10 multiplied by itself seven times. In the pH notation this is abbreviated to 7. At pH 5, which means an acid condition, there would be present $\frac{1}{10^5}$ or $\frac{1}{100,000}$ gramme per litre.

very acid fairly acid slightly acid alkaline

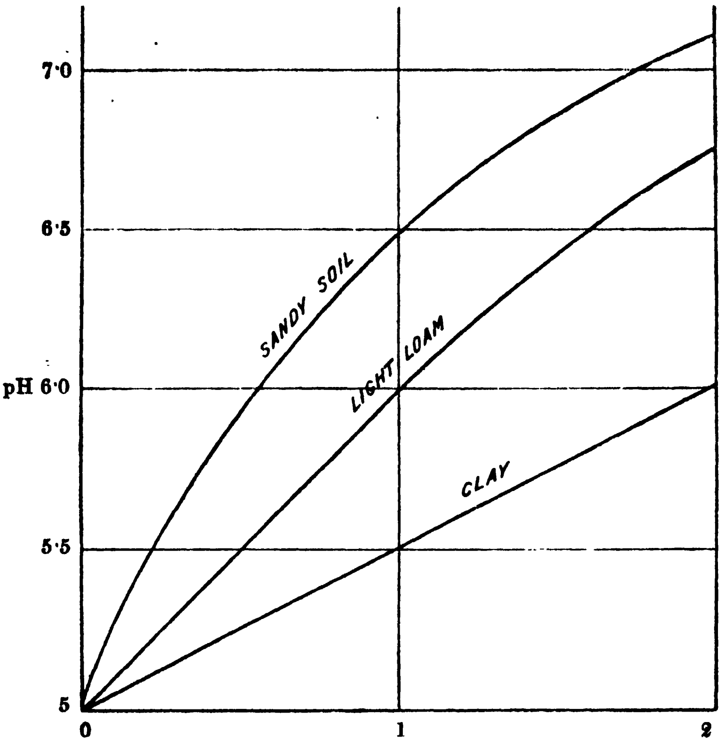
——4 5 6 7 8——

It must be pointed out that the intensity of acidity increases very rapidly as the pH figure decreases. At pH 6, for instance, the intensity of the acidity is ten times that at pH 7; at pH 5 it is 100 times; at pH 4 it is 1,000 times and so on. A small change in pH thus indicates a considerable change in the acid state of the soil and its suitability for a particular crop.

Factors affecting the Dressing of Lime to be applied.—From the acid or alkaline state of the soil, as shown by the pH scale, we can tell whether or not lime is required. Before we can say how much lime should be added, two other aspects, apart from the very practical one of cost, should be considered.

(*a*) *The crop rotation.*—The crops grown and the stage in the crop rotation must be taken into account. Lucerne and sugar beet require ample supplies of lime in the soil, and prefer neutral or slightly alkaline conditions. An experiment carried out in Sweden showed, for instance, that if the yield of sugar beet at pH 7·5 be taken as 100, that from a soil at pH 6·0 may be as low as 34. Peas, beans, clover and legumes generally, barley and wheat do not require so much lime, and a slightly acid soil will be found satisfactory. Towards the end of the rotation, when a considerable amount of lime has been removed from the soil, oats and potatoes will be found to grow well under conditions that are distinctly acid. The ideal liming plan is thus to apply the dressing some time before planting a crop that demands a good supply of lime. During the rotation, the lime which has combined with the soil is gradually removed by the drainage water and by the crops. Crops more tolerant of acid conditions may be grown at a point in the rotation which is further removed from the application of lime.

(*b*) *Texture.*—The actual reduction in acidity brought about by the addition of a given amount of lime varies from soil to soil. It depends largely on the texture of the soil and this in turn is influenced to a considerable extent by the amounts of clay and decomposing organic matter present. The importance of soil texture in the problem of liming may be seen from the diagram below, in which the same amount of lime has been added to three soils all of the same initial acidity.



Tons of Lime per acre

The Effect of Lime in Reducing Soil Acidity

It will be seen that 1 ton of lime reduces the acidity from pH 5 to 6·5 in the sandy soil, from 5 to 6·0 in the light loam and from 5 to only 5·5 in the clay. To get these three soils into a condition suitable for barley, hay or pasture, for instance, different dressings would be required; for the sandy soil half a ton would be needed, for the light loam 1 ton, and for the clay 2 tons. Although the need for lime may be as great on the sandy soil as on the clay soil, the sandy soil will require much less lime to neutralise its acidity. It certainly would not be wise to assume that, because a heavy soil requires a dressing of 2 tons per acre, a lighter soil with the same initial acidity would require the same dressing. Not only is there the question of unnecessary expense, but there may be a danger of overliming. Even a crop such as sugar beet, which is highly sensitive to acid conditions, may be injured by too much lime. For advice in the matter of liming the farmer should apply in the first instance to the County Organiser.

Effect of Lime on Soil Acidity.—To show the effects of an application of lime, an account may be given of a recent experiment carried out on two soils from the north-east of Scotland. The soils were both within the fairly acid range, and both contained about the same amount of available lime. Each soil was limed at two different rates—1 ton per acre and 2 tons per acre of slaked lime. The soils were sampled and analysed before liming, and at intervals of 6, 12 and 36 months after liming. Both soils were of a loamy texture, but preliminary laboratory tests showed that when similar amounts of lime were added to both soils, A did not reach a pH value as near to the neutral point as did B. The process of acid neutralisation in the field was found to be similar to that obtained in the laboratory. The field results are given in the following table:—

Changes in pH Value of Soil caused by Liming

	Amount of lime applied	Before liming	6 months after liming	12 months after liming	36 months after liming
Soil A . .	1 ton	5·6	5·8	5·8	5·8
	2 tons	5·6	6·2	6·3	6·1
Soil B . .	1 ton	5·7	6·3	6·3	5·9
	2 tons	5·7	7·0	6·5	6·4

Changes in Available Lime in the Soil (lb. per acre)

	Amount of lime applied	Before liming	6 months after liming	12 months after liming	36 months after liming
Soil A . .	1 ton	4,360	5,070	4,660	4,600
	2 tons	4,360	6,250	6,250	6,250
Soil B . .	1 ton	4,280	5,620	5,280	4,690
	2 tons	4,280	6,960	6,490	5,340

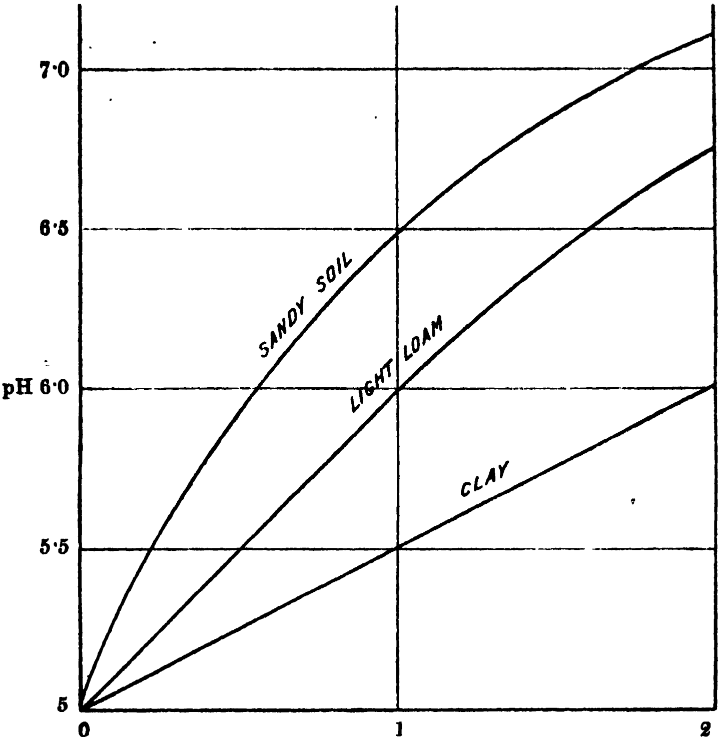
The residual values in this experiment can be seen from the table. At the end of three years both soils still show the effects of liming, but the rate of falling off is different in the two cases. Soil A, which has taken up the smaller percentage of the lime applied, shows a drop in lime content on the 1-ton plots, but no falling away on the 2-ton plots. Soil B which has taken up the greater amount of lime has lost a considerable amount again, and at the end of three years has rather less lime than the heavier soil. The pH figures also show that this soil is again becoming acid, particularly where only one ton of lime has been applied.

The amount of lime available to the plant may also be expressed as a percentage of the maximum that the soil is capable of holding.

	Before liming per cent	6 months after liming per cent	36 months after liming per cent
Soil A—1 ton per acre . .	54	61	57
2 ,, ,, . .	54	73	73
Soil B—1 ton per acre . .	50	75	57
2 ,, ,, . .	50	93	65

The figures show that the lighter soil had almost reached saturation following the application of two tons of lime, but that the lime content fell comparatively rapidly over the next two years.

On the light sandy soils, frequent small dressings of lime are likely to be not only less wasteful, but more effective than heavier dressings at longer intervals. It may also be pointed out that the question of a lime reserve is of greater importance on a light soil.



Tons of Lime per acre

The Effect of Lime in Reducing Soil Acidity

It will be seen that 1 ton of lime reduces the acidity from pH 5 to 6·5 in the sandy soil, from 5 to 6·0 in the light loam and from 5 to only 5·5 in the clay. To get these three soils into a condition suitable for barley, hay or pasture, for instance, different dressings would be required; for the sandy soil half a ton would be needed, for the light loam 1 ton, and for the clay 2 tons. Although the need for lime may be as great on the sandy soil as on the clay soil, the sandy soil will require much less lime to neutralise its acidity. It certainly would not be wise to assume that, because a heavy soil requires a dressing of 2 tons per acre, a lighter soil with the same initial acidity would require the same dressing. Not only is there the question of unnecessary expense, but there may be a danger of overliming. Even a crop such as sugar beet, which is highly sensitive to acid conditions, may be injured by too much lime. For advice in the matter of liming the farmer should apply in the first instance to the County Organiser.

Effect of Lime on Soil Acidity.—To show the effects of an application of lime, an account may be given of a recent experiment carried out on two soils from the north-east of Scotland. The soils were both within the fairly acid range, and both contained about the same amount of available lime. Each soil was limed at two different rates—1 ton per acre and 2 tons per acre of slaked lime. The soils were sampled and analysed before liming, and at intervals of 6, 12 and 36 months after liming. Both soils were of a loamy texture, but preliminary laboratory tests showed that when similar amounts of lime were added to both soils, A did not reach a pH value as near to the neutral point as did B. The process of acid neutralisation in the field was found to be similar to that obtained in the laboratory. The field results are given in the following table:—

Changes in pH Value of Soil caused by Liming

	Amount of lime applied	Before liming	6 months after liming	12 months after liming	36 months after liming
Soil A . .	1 ton	5·6	5·8	5·8	5·8
	2 tons	5·6	6·2	6·3	6·1
Soil B . .	1 ton	5·7	6·3	6·3	5·9
	2 tons	5·7	7·0	6·5	6·4

Changes in Available Lime in the Soil (lb. per acre)

	Amount of lime applied	Before liming	6 months after liming	12 months after liming	36 months after liming
Soil A . .	1 ton	4,360	5,070	4,660	4,600
	2 tons	4,360	6,250	6,250	6,250
Soil B . .	1 ton	4,280	5,620	5,280	4,690
	2 tons	4,280	6,960	6,490	5,340

The residual values in this experiment can be seen from the table. At the end of three years both soils still show the effects of liming, but the rate of falling off is different in the two cases. Soil A, which has taken up the smaller percentage of the lime applied, shows a drop in lime content on the 1-ton plots, but no falling away on the 2-ton plots. Soil B which has taken up the greater amount of lime has lost a considerable amount again, and at the end of three years has rather less lime than the heavier soil. The pH figures also show that this soil is again becoming acid, particularly where only one ton of lime has been applied.

The amount of lime available to the plant may also be expressed as a percentage of the maximum that the soil is capable of holding.

	Before liming per cent	6 months after liming per cent	36 months after liming per cent
Soil A—1 ton per acre . .	54	61	57
2 ,, ,, . .	54	73	73
Soil B—1 ton per acre . .	50	75	57
2 ,, ,, . .	50	93	65

The figures show that the lighter soil had almost reached saturation following the application of two tons of lime, but that the lime content fell comparatively rapidly over the next two years.

On the light sandy soils, frequent small dressings of lime are likely to be not only less wasteful, but more effective than heavier dressings at longer intervals. It may also be pointed out that the question of a lime reserve is of greater importance on a light soil.

Unusual demands made on the lime by excessive leaching or by crop removal may bring the lime content to the danger point. Although the pH value and the amount of lime expressed as a percentage of the maximum that can be held do not show a serious condition, the actual amount of lime present may be small, and heavy demands may quickly result in an impoverished lime status. On the other hand, a soil well supplied with organic matter may be in a more acid condition, have a lower lime saturation, and yet a greater absolute amount of lime. The lime in such a soil will not be so readily lost and crop failure is not so likely to occur. These considerations may give some indication of the value of a preliminary examination in order to estimate the amount of lime required to render a given soil suitable for a particular crop, and the importance of subsequent tests to determine the residual value of the lime.

Effect of Lime on the Permeability of the Soil.—Liming also improves the physical condition of certain soils. A heavy soil is not easily penetrated by water because of the sticky nature of the clay. If this stickiness could be lessened, there would be less danger of waterlogging and the soil would be easier to work. The undesirable character of heavy soils is due to the clay being present in the form of small individual particles. The application of lime causes these small particles to form aggregates or crumbs, and this results in a more open soil. To get an idea of the improvement in drainage due to liming, samples of soil to a depth of 9 inches were taken from limed and unlimed plots. Stones were removed from the samples and the soils were gently packed into narrow glass lamp chimneys, fitted at the base with a gauze and a circle of blotting paper. The same depth of soil was used in each experiment. The soils were thoroughly moistened, a given volume of water was added to each and the time noted for the complete drainage of the added water. The figures below refer to the number of minutes taken for a given volume of water to drain through a given depth of wet soil.

	Unlimed Minutes	1 ton per acre Minutes	2 tons per acre Minutes
Soil A	60	50	37
Soil B	70	60	45

These results were obtained 12 months after liming. At the end of three years further samples were taken and the experiment repeated. The limed soils again showed better drainage than the unlimed. Owing to the very artificial nature of the test, which was due chiefly to the difficulty of getting the different samples of soil to settle in the cylinders to a comparable extent, no great significance should be attached to the actual figures. These do show, however, that liming improves drainage in a heavy soil, that the extent of the improvement increases with the amount of lime, and that the effect persists for a number of years. In order to find whether liming had any influence on the drainage of soil in its natural state use was made of a metal cylinder 3 inches in diameter and

8 inches long. This was driven into the soil to a depth of 4 inches. Water was poured into the cylinder and allowed to drain away. More water was then added to a level 1 inch above the soil surface and the time noted for the drainage of this second addition of water. Some difficulty was encountered owing to stones forming drainage channels between the soil and the cylinder. The test was carried out a number of times on unlimed and heavily limed plots at locality A, and the following drainage times were obtained:—

	Minutes	Minutes	Minutes	Minutes
Unlimed	65	127	48	37
Limed	32	114	26	24

The figures point fairly conclusively to improved drainage in the top few inches of soil resulting from the application of lime.

It has been mentioned already that the improved soil conditions following on liming will result in benefit to crops over a number of years. It is well known, for instance, that on a limed pasture where the soil conditions are suitable for useful grasses, bent does not have the same opportunity to take hold as on pasture where lime is needed. Although the rate of uptake of the lime by the soil may vary, some improvement in the crop may be noticed even in the first year. Thus at locality A, where turnips were grown after liming, the lime resulted in a greater growth of tops and a deeper green colour; the effect of the two-ton application was greater than that of the one-ton. The yield of roots from the unlimed areas was 465 cwt. per acre, and from the heavily limed areas 496 cwt., an increase due to liming of 31 cwt. per acre.

Lime is a necessary plant food and as such plays a definite part in the life of the plant. In addition to neutralising harmful soil acids and to improving drainage, effects which are specifically referred to above, lime has several other uses as a soil improver. Its application to a sour or acid soil is usually accompanied by marked improvements both in the growth and in the feeding value of the crop. Lime plays a very important part in breaking down organic material in the soil into useful plant food, and it helps the plants to make full use of added manures. Where acid fertilisers such as sulphate of ammonia, which uses up the lime in the soil, are being used regularly the need for regular dressings is, of course, of particular importance. The value of lime in counteracting finger-and-toe disease in turnips and related crops is also well known.

OBSERVATIONS ON THE POTATO EELWORM

(*Heterodera schachtii*)

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Introduction.—In the autumn of 1927, Mr W. M. Findlay, Superintendent of Experiments at Craibstone Experimental Station, commenced a small plot experiment with a view to finding out (*a*) what type of soil is best suited for the production of healthy seed potatoes, (*b*) which of the well-known varieties is least liable to degenerate when the soil is constantly used for the production of potatoes. Three types of soil were selected for the experiment, clay, peat and gravel, all of which were virgin for potatoes. The clay soil was obtained from a farm near the coast of Aberdeenshire, the peat from an uncultivated area of ground at Craibstone, and the gravel from a local sand-pit. To the latter there was added a small amount of loam in which potatoes had not been grown within living memory. The experiment was conducted in duplicate, the plots being arranged as shown in Figure 1.

FIGURE 1

Clay	Peat	Gravel	Clay	Peat	Gravel
Golden Wonder	Golden Wonder	Golden Wonder	British Queen	British Queen	British Queen
Kerr's Pink	Kerr's Pink	Kerr's Pink	Sharpe's Express	Sharpe's Express	Sharpe's Express
Great Scot	Great Scot	Great Scot	Epicure	Epicure	Epicure
Di Vernon	Di Vernon	Di Vernon	Duke of York	Duke of York	Duke of York

Mechanical analyses of samples of air-dried soil from the various plots gave the following results:—

MECHANICAL ANALYSES OF CLAY, PEAT AND GRAVEL SOILS

	Clay	Peat	Gravel
Coarse Sand	20·92	30·55	60·70
Fine Sand	29·25	11·25	18·40
Silt	17·87	6·25	6·50
Clay	17·50	4·75	3·00
Loss on Ignition	11·88	38·20	8·86
Moisture	3·79	10·98	2·00
Difference	- 1·14	- 1·98	0·54
	100·00	100·00	100·00

The above analyses, which were carried out according to the Agricultural Education Association's standard method, 1927, show that the clay is of the typical heavy type found in the North of Scotland, the peat has a fairly high percentage of mineral matter, while the gravel calls for no special comment.

The plots measured 7 by 7 feet and were separated by boards measuring ¾ inch thick by 12 inches deep sunk to a depth of 8 inches. The original soil was removed to a depth of 8 inches from each plot and replaced by fresh soils from the sources already mentioned.

Each year all six plots received the same manurial treatment—dung at the rate of 12 tons per acre and artificials at the rate of 6 cwt. per acre (sulphate of ammonia 1½ cwt., superphosphate 3½ cwt. and muriate of potash 1 cwt.).

Four early, two second early and two late varieties of potatoes were selected for trial, and Figure 1 shows their names and arrangement in the plots. Three tubers of each variety were planted in each type of soil. All tubers were sprouted and planted about the middle of April. The early varieties were harvested in September and the late varieties towards the end of October of each year. Seed tubers for the following year were selected at the time of lifting so that no new seed was introduced.

The yields from the various plots from 1928 to 1936 are shown in Table I and the variety yields from 1930 to 1936 are shown in Table II.

TABLE I—SHOWING YIELD OF POTATOES FROM EACH PLOT FROM 1928 TO 1936

No. of Plot	Type of Soil	1928	1829	1930	1931	1932	1933	1934	1935	1936
		lb. oz.	lb. oz.	lb. oz.	lb. oz	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
1	Clay	Turnips	32 14	29 8	23 13	28 10	28 5	30 4	15 2	8 14
2	Peat		32 3	26 9	20 0	24 7	20 9	9 7	10 2	5 4
3	Gravel ..		26 15	23 13	19 3	25 8	25 4	14 7	11 12	8 3
4	Clay	23 13	Turnips	19 15	17 11	21 7	26 5	23 0	8 1	6 5
5	Peat	33 7		24 14	24 1	25 6	19 12	15 4	8 13	4 3
6	Gravel ...	30 11		20 10	19 13	20 10	9 2	11 10	6 4	9 8

TABLE II—SHOWING TOTAL YIELD OF EACH VARIETY FROM 1930 TO 1936

Clay

Variety	1930		1931		1932		1933		1934		1935		1936	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb	oz.	lb.	oz.
Duke of York ...	4	0	3	4	4	11	4	4	2	6	1	7	0	11
Di Vernon	6	8	6	9	6	13	4	11	5	14	1	15	2	4
Epicure	4	10	4	7	7	7	8	12	7	2	2	14	2	10
Sharpe's Express ...	4	4	3	4	2	7	4	12	3	12	0	14	0	4
British Queen ...	7	1	6	12	6	14	8	9	9	12	2	14	2	12
Great Scot	10	4	5	0	6	15	9	6	7	5	4	5	1	4
Kerr's Pink ...	8	12	7	2	8	9	9	6	10	0	3	12	4	8
Golden Wonder ...	4	0	5	2	6	5	4	14	7	1	5	2	0	14

Peat

Variety	1930		1931		1932		1933		1934		1935		1936	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Duke of York ...	6	1	5	11	7	10	1	12	1	5	0	15	0	1
Di Vernon	5	7	4	10	6	5	3	15	0	14	0	9	0	9
Epicure	8	6	7	10	8	7	6	10	8	6	4	4	0	14
Sharpe's Express ...	4	0	2	14	2	13	4	4	1	3	1	3	0	8
British Queen ...	6	7	7	14	6	8	7	2	4	6	2	7	2	12
Great Scot	6	11	5	10	6	8	6	4	2	3	3	12	0	8
Kerr's Pink ...	9	11	5	6	7	5	7	10	3	3	2	15	2	13
Golden Wonder ..	4	12	4	6	4	5	2	12	3	3	2	14	1	6

Gravel

Variety	1930		1931		1932		1933		1934		1935		1936	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Duke of York ...	4	12	4	6	5	3	1	10	1	4	0	9	0	6
Di Vernon	3	3	3	1	3	6	2	10	0	10	1	0	0	12
Epicure	5	8	4	8	7	2	4	3	4	8	2	0	4	6
Sharpe's Express ...	2	13	4	5	3	10	1	8	0	5	0	13	1	6
British Queen ...	7	9	6	10	4	11	1	13	5	9	2	14	3	6
Great Scot	6	0	4	7	7	4	8	10	4	0	2	6	0	13
Kerr's Pink ..	8	15	7	2	6	12	8	4	3	14	4	4	5	0
Golden Wonder ...	4	9	8	2	5	12	5	12	5	15	4	2	1	10

In the summer of 1936 the attention of the writer was drawn to the fact that several of the plants were stunted and unhealthy and examination of the roots of a plant from plot 6 showed eelworm cysts in large numbers. Further examinations proved that all the plants were infested with *Heterodera schachtii* cysts, some more heavily than others. There was no evidence of damage to the roots by any other factor.

Realizing that a serious attack of potato eelworm had completely defeated the object of his experiment, Mr Findlay handed over the experimental plots to the writer for future investigation. The latter wishes to express his indebtedness to Mr Findlay for the valuable data thus placed at his disposal.

Hitherto, no published work has appeared on the subject of potato eelworm disease in the North of Scotland as it is of minor economic importance, being confined almost entirely to gardens and allotments. This is in marked contrast to the position in the potato areas of England and South-West Scotland, where the disease is very prevalent and has been the subject of investigation by many workers. The object of this article is to record the findings, in regard to certain aspects of the problem, in an outbreak of potato sickness, which has occurred under unusual circumstances.

Technique.—The method adopted for determining the number of cysts in the soil was, except for certain details, similar to that devised by Morgan (1925). On lifting the potatoes the plots were forked three times to a depth of 6 inches and finally raked with a view to distributing the cysts as evenly as possible throughout the soil. Ten small surface samples were lifted by hand from certain points arranged diagonally across each plot and these were mixed together to give one large sample from each plot. The samples were air-dried and rubbed down in a mortar and 5 samples of 10 grms. each of soil, passing through a finely meshed sieve, were weighed out for estimating the number of cysts present. Each sample was transferred to a narrow-necked flask, water added, and the flask vigorously shaken. The flask was then filled to the brim and left standing for 3 minutes. At the end of this time the cysts and organic matter which had floated to the surface were poured off on to a filter paper supported on a sieve. The flask was refilled and the process repeated until all the cysts were transferred to the filter paper. When the latter was sufficiently dry its contents were brushed into a petri dish and the cysts isolated with the aid of a lens and counted.

Source of Infection.—In view of the history of the plots the question naturally arises, " How did they become infected with *Heterodera schachtii?* "

The answer to this question is not a simple one, when it is borne in mind that (*a*) all three types of soil had never produced potatoes within living memory; (*b*) samples of soil from all neighbouring plots and from the rest of the field were examined and found to be free from eelworm cysts; (*c*) the original seed was free from cysts as far as can be ascertained. They were grown where eelworm disease was not known and as they were sprouted in boxes the risk of infestation was reduced to a minimum; (*d*) the plots were isolated and arranged in such a way that any chance of contamination from the boots of visitors was unlikely. Indeed, the chances of outside infection seem so remote that it is more reasonable to suggest that *H. schachtii* was present, and presumably living on grasses or weeds, before the soils were lifted.

In this case a rapid increase of the parasite must have taken place as a result of the soil having been cropped continuously for eight years with a suitable host plant.

In cases of potato eelworm disease it is usually assumed that the soil becomes infected with cysts from some outside source, but the possibility that the parasite is present in all soils and capable of quickly adapting itself on the potato seems worthy of investigation.

Relationship between Size of Cyst and Type of Soil.—Triffitt (1928) observed that when a Lincolnshire potato strain of *Heterodera schachtii* was transferred to the heavy soils of Hertfordshire, the cysts showed a marked decrease in size after a period of two years. In a later paper Triffitt (1929) concluded that " an unfavourable environment such as a heavy soil has the effect of greatly reducing the average size of the cyst."

Table III shows the minimum, maximum and average measurements of the length, thickness and length of neck of five of the smallest and five of the largest cysts from each plot. It will be observed that with the exception of the cysts from plot 5, which are slightly smaller, the dimensions of the cysts from all three types of soil are remarkably similar. Since all conditions are equal except that of soil it may be definitely concluded that a heavy soil does not diminish the size or alter the shape of the cysts in any way.

The alteration in the size of the cysts obtained by Triffitt in transferring the Lincolnshire potato strain to Hertfordshire soil would appear, as revealed by her in a more recent paper (1935), to be due to the presence of " microcysts " which she mistook for small eelworm cysts.

Relationship between Intensity of Disease and Cyst Content.—One of the most puzzling problems in regard to potato sickness is the fact that the severity of the disease, as judged by the appearance of the foliage and the yield of tubers, often bears little or no relationship to the cyst content of the soil. Healthy plants have frequently been observed to grow on soil containing abundant cysts—an observation which led to the suggestion that potato eelworm is not the sole cause of potato sickness.

Morgan and Peters (1929) investigated the problem, but were unable to establish a definite relationship between the intensity of the disease and number of cysts in the soil. Carroll (1933) carried out a series of pot experiments in which he endeavoured to eliminate such favourable factors as fertility of soil, manuring, quality of seed used, and date of planting. From his experiments he concluded that " potato sickness is caused by the attack of the potato eelworm " and that " the intensity of the disease is influenced very much by the number of eelworms present in the soil."

In a later paper Carroll and M'Mahon (1935) do not claim that a relationship exists between cyst content and intensity of potato sickness when the cyst content of the soil is over about 4 per c.c.

TABLE III—Comparing the Size of the Cysts from each Plot

All measurements in millimetres

	Length			Thickness			Proportion of Length to Thickness			Length of Neck			Proportion of Length to Length of Neck		
	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.
Clay (1) ...	0·36	0·72	0·52	0·29	0·56	0·45	1·24	1·30	1·16	0·040	0·130	0·076	9·0	5·5	6·80
Peat (2) ...	0·36	0 74	0·54	0·31	0·58	0·47	1 16	1·30	1·15	0·028	0·122	0·63	13·0	6·1	8·60
Gravel (3) ...	0·36	0·77	0·54	0·35	0·67	0·40	1·03	1·15	1·30	0·032	0·16	0·088	11·3	4·8	6·10
Clay (4) ...	0·39	0·73	0·55	0·31	0·69	0·47	1·26	1·05	1·18	0·067	0·162	0·082	5·8	4·5	6·70
Peat (5) ...	0·21	0·70	0·47	0·19	0·65	0·43	1·10	1·07	1·10	0·010	0·091	0·039	21·0	7·7	12·10
Gravel (6) ...	0·35	0·76	0·57	0·25	0·66	0·48	1·40	1·40	1·18	0·048	0·143	0·084	7·3	5·3	6 80

Note.—Length includes Length of Neck

The Craibstone experiment tends to show that the intensity of the disease as judged by the yield of tubers bears no relationship to the eelworm content of the soil. For instance plot 6 (Table IV) shows the highest yield of 9 lb. 8 oz. and also the highest number of cysts, while plot 5 with the lowest yield of tubers reveals a relatively small number of cysts.

These results cannot, however, be regarded as conclusive, since there is one factor present which may have had an influence on the number of cysts, viz., soil. Indeed, since soil is the only variable factor in this experiment, it is reasonable to suggest that the low cyst content obtained from the clay plots may have been due to the heavy nature of the soil. This factor alone, however, does not explain why the heaviest crop has been obtained from the soil with the greatest abundance of eelworm. Table I shows that throughout the first few years of the experiment, when eelworm disease was absent, the clay soil usually gave a higher yield than the gravel soil. But now, in 1936, the reverse is the case and this in spite of the fact that the gravel soil reveals twice the number of eelworm cysts.

TABLE IV—SHOWING CYST CONTENT, pH VALUE AND YIELD OF TUBERS FROM EACH PLOT

No. of Plot	Type of Soil	pH Value	No. of Cysts in individual samples of 10 grms.			Yield of tubers	
					Average	lb.	oz.
1	Clay ...	5·55	53, 60, 67, 71, 71	=	64	8	14
2	Peat ...	5·60	93, 101, 109, 114, 92	=	102	5	4
3	Gravel ...	5·35	89, 90, 106, 79, 70	=	91	7	9
4	Clay ...	5·50	40, 36, 35, 35, 30	=	35	6	5
5	Peat ...	5·35	60, 74, 58, 75, 70	=	67	4	3
6	Gravel ...	5·65	123, 103, 95, 102, 94	=	104	9	8

It is evident, therefore, that although the potato eelworm is the chief pathogenic factor in this case some other factor or factors appear to be present which are operating to a greater degree in the clay soil. The existence of such factors has previously been mentioned by other workers and Triffitt (1931) suggests that "they probably operate by producing conditions unsuitable for plant growth, and thus checking the compensatory output of secondary roots, and preventing the plant from overcoming the preliminary set-back in growth resulting from eelworm attack."

Relationship between Cyst Content and pH Value of the Soil.—Peters (1926) carried out investigations on the problem whether the incidence of potato eelworm bears any relationship to the pH value of the soil. As a result of his extensive tests he found that a definite correlation existed between pH value and cyst concentration, numerous cysts being found in samples giving solutions of pH : 6·0, and few in samples giving solutions of pH : 6·7. From his investigations he concluded that a soil having pH of 7·0 would be unfavourable to the eelworm.

O'Brien and Prentice (1930) in their investigations on the potato eelworm in Ayrshire soils found that a relationship existed between the severity of eelworm disease and acidity of the soil and observed that plants growing in soils with a pH between 4·2 and 5·0 tended to suffer less from eelworm disease than these growing in soils of pH outwith these limits. They hint, however, that soil reaction probably influences the vigour of the plant to a much greater extent than the activities of the eelworm.

Carroll (1933) was unable to establish any relationship between the pH value of soil and cyst content and disproved Peter's conclusions that a soil with a pH value of 7 (and over) was unfavourable to eelworm. The writer's investigations are in agreement with Carroll's as indicated in Table IV. The pH determinations were carried out by Mr Walter Moore of the Agricultural Chemistry Department, who employed the Glass Electrode Method.

It will be seen from these results that, in spite of the fact that a marked variation occurred in the eelworm content, the pH value of the soil always remained within the narrow range of 5·35-5·65.

Varietal Resistance of Potatoes to the Effects of Eelworm Infestation.—Although the susceptibility of the various varieties of potatoes to eelworm attack has not been fully investigated it is interesting to note that some workers have drawn attention to the better results obtained from early varieties as compared with second early and late varieties. O'Brien and Prentice (1930) state that "in Ayrshire, early potatoes resist the effects of eelworm attack much better than lates. In badly infested soil the yield from the former may be from 2-3 tons per acre, and from the latter only one ton."

In the Rush district, Co. Dublin, Carroll (1935) observed that "early potatoes seldom suffer badly from potato sickness whereas second early and late varieties are often almost complete failures." According to Carroll the higher yields obtained from early varieties are explained by the fact that "early varieties are planted as sprouted tubers very early in the year, evidently before the soil temperature is sufficiently high to permit of extensive hatching of eelworm eggs, and as a result the plants are large and well established before normal hatching commences."

In the light of these observations it is interesting to compare the yields of the different varieties in the Craibstone plots from 1930 to 1936 as shown in Table II. The varieties are listed according to their degree of earliness.

The results show that in 1936 the late varieties have produced on the whole a greater weight of tubers than the early varieties. Kerr's Pink, in particular, gave consistently high yields, and, as it also presented a much healthier appearance above ground, it seems reasonable to conclude that this variety possesses a relatively high degree of resistance to the effects of eelworm attack.

The early varieties, on the other hand, gave very poor results. The variety Duke of York, which is the earliest potato grown in the North of Scotland, produced the lowest yield of any variety in the peat and gravel plots, and the second lowest yield in the clay plot. In the peat plot it proved to be a complete failure, only one small tuber weighing 1 oz. being obtained from three plants. Poor yields were also obtained from Sharpe's Express, but it is noteworthy that Epicure gave surprisingly good results, particularly in the gravel plot where the yield of tubers almost equalled that of Kerr's Pink.

Similar remarks may be applied to the results for 1935, the late varieties again proving to be higher producers than the early varieties. The one exception is that of Epicure in the peat plot where the yield is actually much greater than that obtained from any other variety.

Further evidence of the resistance of Epicure to the effects of eelworm invasion is seen in consideration of the yields of those plots in which eelworm disease presumably first made its appearance, namely, gravel plot 6 in 1933, peat plot 5 in 1934 and clay plot 4 in 1935. For instance, in peat plot 5 the yield from Epicure in 1934 is actually 7 times greater than that from its neighbouring plants Duke of York and Sharpe's Express.

In 1936 Golden Wonder gave unexpectedly poor yields in all three plots, but the season was unsuitable for this variety which gave equally poor results in adjacent fields.

Although further investigations are necessary in order to arrive at a true explanation of the relatively good results shown by Epicure and Kerr's Pink in eelworm-infested soil, these are in the writer's opinion closely connected with the ability of these varieties to form their tubers rapidly, or, to use the commercial phrase, to " bulk " early. Certain varieties possess this ability to a greater degree than others and it is obvious that it must have an important influence on the ultimate yield of a plant invaded by a parasite which lives on root sap. Epicure and Kerr's Pink are recognised as varieties that " bulk " early and it is perhaps significant that the best yields have been obtained from these varieties. It appears equally significant that the varieties Duke of York and particularly Sharpe's Express which have the least ability to " bulk " early have yielded the poorest results.

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THE VARIATION IN RETAIL MILK PRICES BETWEEN DIFFERENT AREAS

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THE provisions of the Agricultural Marketing Acts enable agricultural producers, when organised, to control prices in so far as control of the home supply makes this possible. Under the Milk Marketing Schemes in England and Wales and in the main area of Scotland, the Boards have fixed the wholesale prices of liquid milk at a uniform level throughout their respective areas. Not only have they established wholesale prices, but retail prices also have been prescribed. In Scotland minimum retail milk prices have been fixed at a uniform level throughout the area of the scheme, and in England and Wales three minimum retail prices were prescribed, depending only upon the size of the town.(1) It is true that in England a reduction below these minimum retail prices is permitted, when the majority of retailers so request; none the less, as Table 1 and the Diagram show, prices are fairly uniform throughout the country.

One of the criticisms levelled against the Milk Marketing Boards is that they have tended to level out retail prices throughout the country, and so deprive consumers living in the areas where production is cheaper of the advantage of paying less for milk. As the Reorganization Commission for Milk for Great Britain said,

> " there is no reason in equity why distributors, and therefore consumers, throughout the country, should pay a price based on the cost of supplying the largest of consuming centres when the cost of supplying their own neighbourhood is less."(2)

While, however, such criticism has been made frequently, little statistical evidence has been produced to support it. No analysis has been made of the variation in retail prices *before* the Schemes started, so that it has been difficult to measure the change.

This article produces such evidence for areas in Southern Scotland and Northern England. Records of the prices charged for liquid milk were obtained from Medical Officers of Health, Co-operative Societies, the Milk Marketing Board and official sources. In some cases no one price prevailed; thus in Manchester, until the introduction of the Milk Marketing Scheme, bottled milk was retailed at ½d. per quart more than loose milk. Moreover, in some towns the price was different in different districts. In these cases the price most representative in working-class districts, for the type of milk most generally retailed there, was taken.

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(1) An additional higher price was prescribed for towns of over 25,000 people in the South-Eastern region.

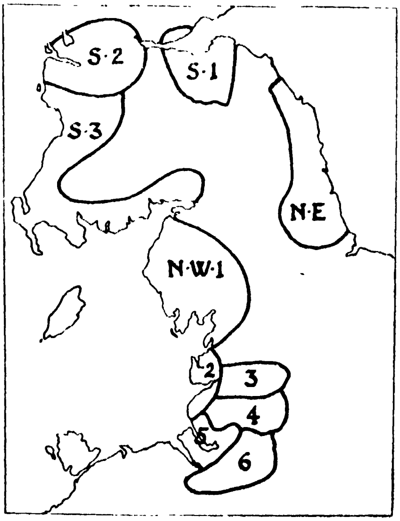
(2) *Milk—Report of the Reorganization Commission for Great Britain*, Ministry of Agriculture, Economic Series No. 44, 1936, p. 199.

The areas for which prices were obtained included five population centres, Edinburgh, Glasgow and the other Clydeside industrial towns, Newcastle and the Tyneside towns, Manchester and its surrounding industrial area, and Liverpool and Birkenhead, as well as several large producing and exporting areas. It was hoped that in this area the different milk sheds were sufficiently demarcated to show clearly any differences in price that might exist between producing and consuming areas.

The towns from which records were collected may be grouped into ten areas, as shown on the accompanying map.

DIAGRAM I

Areas where Retail Milk Prices were obtained



Three of them are in Scotland and seven in England. In Scotland one, the Eastern, centres on Edinburgh; another, the Western, centres on Glasgow and the other Clydeside towns; the third, the South-West, covers the great milk-producing area of Ayr, Wigtown, etc., and follows round the north coast of the Solway Firth. In England one area is in the North-East, extending from Berwick to south Durham, and centring round Newcastle and South Shields. The remaining six areas are in the North-West; the first covers Westmoreland and Cumberland and extends as far south as Lancaster; the second comprises three coastal towns in mid-Lancashire; the third is the northern strip of the great industrial concentration, stretching eastwards to the moors from Preston, and including such towns as Blackburn, Burnley and Darwen; the fourth is the southern half of this industrial area, centring round Manchester and Salford, and including Rochdale, Oldham, Stockport, Bury, Bolton, Wigan and St. Helens; the fifth is the area surrounding the Mersey and Dee estuaries, including Liverpool, Birkenhead, Warrington and Chester; while the sixth is mainly in Cheshire, south of the big industrial area, and includes such towns as Macclesfield and Crewe.

Records were obtained from 106 towns for three periods, 1928-9, the year before the depression set in; 1932-3, the last year before the Milk Marketing Schemes came into force; and 1935-6, the third year of operation of the Schemes. Forty-three of the towns from which records were obtained had populations of over 25,000, 31 had populations between 10,000 and 25,000, and the remaining 32 had populations under 10,000. No records could be obtained from purely rural areas, so that the enquiry cannot substantiate or disprove the contention that prices have increased most in such areas. Since, however, the urban population is about nine times as great as the rural in the country as a whole, and relatively even greater in the northern area, conditions in the towns are of major interest.

The accompanying table shows the average retail prices ruling from October 1935 to September 1936, grouped in towns of varying sizes in the different areas. For this period, data for England were supplied by the Milk Marketing Board for 213 towns, containing a much larger number of small towns than the sample of 74 towns for which figures were also obtained for pre-Scheme years. The figures derived from the larger sample serve as a test for the smaller sample.

[TABLE I

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TABLE 1

UNWEIGHTED AVERAGE RETAIL PRICES IN PENCE PER QUART OF MILK IN TOWNS OF VARIOUS SIZES AND IN VARIOUS AREAS, 1935-6. (Milk Marketing Board sample italicized.)

AREA	No. of towns				Average population in thousands				Prices in towns			
	Large[1]	Medium[2]	Small[3]	Total	Large[1]	Medium[2]	Small[3]	Total	Large[1]	Medium[2]	Small[3]	Total
Scotland									d.	d.	d.	d.
1	2	1	2	5	241	13	4	100	6·0	6·0	6·0	6·0
2	5	5	2	12	266	19	8	120	6·0	6·0	6·0	6·0
3	2	...	13	15	40	...	3	4	6·0	...	6·0	6·0
TOTAL ...	9	6	17	32	210	18	4	65	6·0	6·0	6·0	6·0
England												
North-East	3	8	2	13	142	15	8	43	6·5	6·4	6·0	6·4
	12	*21*	*13*	*46*	*87*	*16*	*7*	*32*	*6·6*	*6·4*	*6·1*	*6·4*
North-West 1 ...	2	3	5	10	55	16	5	18	6·1	6·0	6·0	6·0
	2	*6*	*13*	*21*	*55*	*17*	*5*	*13*	*6·1*	*6·1*	*6·0*	*6·0*
,, 2 ...	2	1	...	3	52	23	...	43	6·5	6·3	...	6·4
	3	*3*	*6*	*12*	*69*	*19*	*4*	*24*	*6·5*	*6·0*	*6·0*	*6·2*
,, 3 ...	6	5	1	12	75	19	4	46	6·0	6·0	5·9	6·0
	9	*11*	*10*	*30*	*66*	*15*	*6*	*27*	*6·1*	*6·0*	*6·0*	*6·0*
,, 4 ...	13	5	1	19	147	17	6	105	6·3	6·2	6·2	6·3
	20	*24*	*24*	*68*	*109*	*17*	*6*	*40*	*6·4*	*6·4*	*6·1*	*6·3*
,, 5 ...	5	...	3	8	233	...	4	147	6·5	..	6·2	6·4
	8	*5*	*4*	*17*	*165*	*17*	*5*	*84*	*6·5*	*6·5*	*6·2*	*6·4*
,, 6 ...	3	3	3	9	49	14	7	23	6·3	6·0	5·9	6·0
	2	*5*	*12*	*19*	*36*	*17*	*4*	*10*	*6·3*	*6·3*	*6·0*	*6·1*
6 areas	31	17	13	61	125	17	5	106	6·3	6·0	6·0	6·2
	44	*54*	*69*	*167*	*102*	*17*	*5*	*34*	*6·3*	*6·3*	*6·0*	*6·2*
TOTAL ...	43	31	32	106	144	17	5	65	6·3	6·1	6·0	6·1

[1] Towns with over 25,000 population in 1931.
[2] ,, ,, between 10,000 and 25,000 population.
[3] ,, ,, under 10,000 population.

Out of the 19 groups, comprising 74 towns, where comparable figures were obtainable from the two sets of data, the average prices were identical in 8 groups, comprising 33 towns; in another 8 groups, including 32 towns, the difference between the two sets of data was only 0·1d. per quart, or less than 2 per cent of the price. Only in one group of 5 towns the difference was 0·2d. and in two groups with 4 towns the difference was 0·3d.

TABLE 2

DISTRIBUTION OF DIFFERENCES IN AVERAGE PRICES BETWEEN THE TWO SETS OF DATA FOR THE REGIONS IN ENGLAND, 1935-6.

Difference between average prices	Number of groups	Number of towns in these groups
0·0d.	8	33
0·1d.	8	32
0·2d.	1	5
0·3d.	2	4

Average prices in the area show a remarkable uniformity. In Scotland the Scottish Milk Marketing Board prescribed a minimum retail price of 6d. per quart, except in May and June, when a reduction to 5d. was permitted. The bulk of distributors, however, since the Board had reduced their minimum margin from that prescribed in the previous year, agreed not to reduce their retail prices in May and June. In only one town in the sample did the bulk of the distributors take advantage of the possible reduction.

In England the Milk Marketing Board prescribed minimum prices of 7d. per quart in winter and 6d. in summer, or an average of $6\frac{1}{2}$d. in towns of over 25,000 inhabitants; of $6\frac{1}{2}$d per quart in winter and 6d. in summer, or an average of $6\frac{1}{4}$d. in towns of between 10,000 and 25,000 inhabitants; and of 5d. per quart in May and June, and 6d. in other months, or an average of $5^{5}/_{6}$d. per quart in towns of under 10,000 inhabitants. Reductions below these minima were permitted, on application from the majority of distributors in any district, and were arranged in a varying number of towns in each area. Some towns, also differing in number from area to area, charged more than the permitted prices; this was particularly true for the small towns, where the price was frequently not reduced to 5d. per quart in May and June.

The actual unweighted average prices charged in the towns in the smaller sample, as shown by Table 1, were, in North-East England, 6·5d. per quart in the large towns, 6·4d. in the medium towns and 6·0d. in the small; in North-West England they were 6·3d. per quart in the large towns, and 6·0d. in both the medium and the small. In the smaller areas average prices varied in the large towns from 6·5d. to 6·0d. per quart, in the medium towns from 6·4d. to 6·0d., and in the small towns only from 6·2d. to 6·0d. This variation, however, of no more than 0·5d. from area to area, was very small.

The essential uniformity of prices is also brought out by the accompanying diagrams, showing the average prices charged in each of the towns in the smaller sample in the winter of 1935-6 and the summer of 1936. Each type of shading represents a range of ½d. per quart in the average retail price, and the average difference between prices in neighbouring types of shading is ½d. per quart. The retail prices charged in all towns for which prices were obtained, within an area of the same type of shading, fall within this ½d. per quart range; there may, however, be some towns within the area, for which prices were not obtained, with prices which do not fall within this range. The shading is, however, reasonably representative of the prices charged within each area.

In the winter of 1935-6 price was 6d. per quart in most areas, but 6½d. and 7d. in the greater part of North-Eastern England and in Southern Lancashire and round the Mersey estuary. The range in price was therefore only 1d. per quart, if one town, Stranraer, in which price was only 5½d., be disregarded. In the summer of 1936 the price was again generally 6d. per quart, though in some small areas it was 5½d., and around Liverpool 6½d. Again the maximum range was 1d. per quart. The number of towns in which the different prices were charged was:—

d. per quart	Winter of 1935-36	Summer of 1936
5·26-5·75	1	2
5·76-6·25	72	102
6·26-6·75	7	2
6·76-7·25	26	—

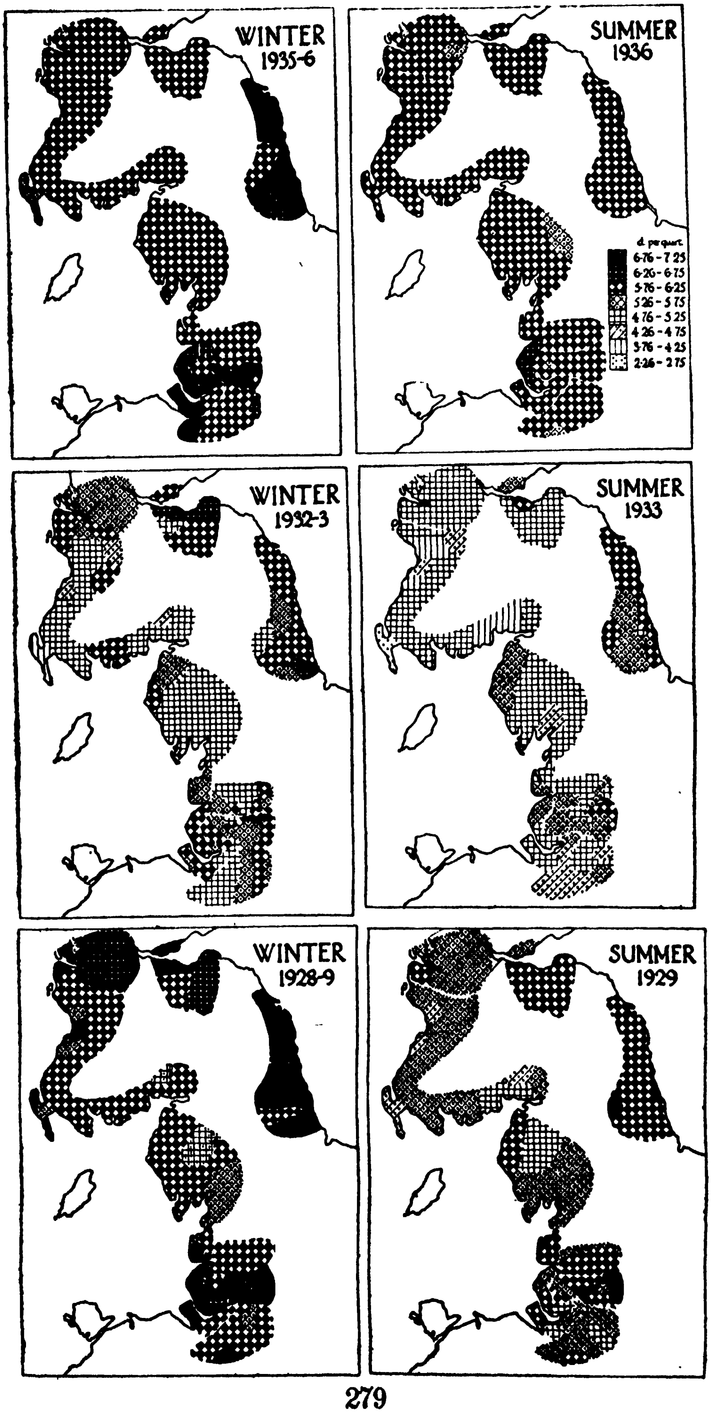
The diagrams for 1935-6 may be compared with those showing prices in the year before the Milk Marketing Scheme started. The difference is at once apparent. The first obvious change is the lower level of prices in 1932-3. In the towns in the sample in Scotland the retail price of milk was 0·5d. per quart lower in winter and 1·2d. lower in summer in 1932-3 than in 1935-6; in North-East England the difference was 0·8d. per quart in winter and 0·4d. in summer; and in North-West England 0·8d. per quart both in winter and summer.

Equally clear, moreover, is the absence of a uniform retail price. In the winter of 1932-3 retail prices showed every gradation for 6½d. per quart in the Edinburgh district, and in small parts of North-East and North-West England to 4½d. per quart in several districts in South-West Scotland and 4d. per quart in Stranraer. Thus the range in prices was so much as 2½d. per quart.

In the summer of 1933 there was an even greater variation. Every gradation existed between 6d. per quart in some of the large population centres to 4d. in some areas in South-West Scotland, while in Stranraer the price was so low as 2½d. per quart. Thus the extreme range was 3½d. per quart.

Diagram II

Average Retail Price of Milk per quart, Winter and Summer, 1935-6, 1932-3 and 1928-9



In 1928-9, when the average price in the selected towns averaged much the same price as in 1935-6, retail prices were by no means uniform throughout the country. They varied continuously from 7d. per quart in the Edinburgh area, most of North-East England, the area surrounding Manchester and its neighbouring industrial towns, and Liverpool, to 5½d. per quart in a number of producing areas, and 5d. in a few. The extreme range was thus 2d. per quart. Similar differences existed in the summer, when prices ranged from 6½d. per quart in some of the large population centres to 4½d. in the Stranraer area of Wigtown, and 5d. and 5½d. over a wide area of sparse population.

TABLE 3

NUMBER OF TOWNS IN WHICH DIFFERENT RETAIL PRICES PREVAILED, WINTER AND SUMMER, 1928-9, 1932-3, AND 1935-6.

Price range d. per quart	Winter			Summer		
	1928-9	1932-3	1935-6	1929	1933	1936
2·26 — 2·75	...	...	...	...	1	...
2·76 — 3·25	...	...	...	...	...	...
3·26 — 3·75	...	..	...	...	...	...
3 76 — 4·25	...	1	...	...	3	...
4·26 — 4·75	...	3	...	4	12	...
4·76 — 5·25	2	31	...	8	48	...
5·26 — 5·75	7	26	1	42	29	2
5·76 — 6·25	46	40	72	42	13	102
6·26 — 6·75	24	5	7	10	...	2
6·76 — 7·25	27	...	26	...	...	...
Unweighted average price	6·3	5·6	6·3	5·7	5·1	6·0

In both the pre-Scheme years, therefore, prices tended to be highest in the big centres of population and lowest in the more distant areas, where cow population was large, such as South-West Scotland, Cumberland and Westmorland and the central part of Cheshire.

Since, as Table 1 indicates, the sample included a larger number of small towns in the producing than in the consuming areas, it might be thought that a large part of the difference in retail prices was due to the lower costs of distribution in these towns, and not to the lower costs of getting the milk to the distributor. If, however, retail prices in towns of varying sizes in the same districts be compared, this hypothesis does not seem to be supported.

The prices in such towns in 1928-9 and 1932-3 are given in

Table 4, while the numbers in each group are given in Table 1. The averages for each of the three big areas show higher averages in the large than in the small towns. This difference, however, is due to the larger number of small towns in the more distant districts. Within each district there is little difference in the average retail prices in towns of different sizes. The difference in retail prices in the various areas must therefore be attributed to their position relatively to the consuming and producing areas, and not to the different costs of distribution in the various areas.

TABLE 4

AVERAGE RETAIL PRICES IN PENCE PER QUART OF MILK IN TOWNS OF VARIOUS SIZES AND IN VARIOUS AREAS, FOR THE YEARS 1928-9 AND 1932-3.

AREA	1928-9				1932-3			
	Large	Medium	Small	Average	Large	Medium	Small	Average
Scotland								
East	6·4	6·3	6·2	6·3	6·1	5·7	5·5	5·8
West	6·1	6·1	6·2	6·1	5·4	5·4	5·4	5·4
South-West	5·6	...	5·6	5·6	4·6	...	4·8	4·7
TOTAL ...	*6·1*	*6·1*	*5·7*	*5·9*	*5·4*	*5·4*	*4·9*	*5·1*
England								
North-East	*6·6*	*6·4*	*6·5*	*6·5*	*5·7*	*5·9*	*5·6*	*5·8*
North-West 1	5·6	5·7	5·6	5·6	5·1	5·1	5·1	5·1
,, 2	6·2	6·0	...	6·1	5·6	5·4	...	5·5
,, 3	5·9	5·9	5·7	5·9	5·2	5·3	5·0	5·2
,, 4	6·4	6·5	5·7	6·5	5·7	5·6	5·5	5·6
,, 5	5·9	...	6·0	6·0	5·6	...	5·1	5·4
,, 6	5·7	5·7	5·8	5·7	5·1	5·0	5·0	5·1
6 areas	*6·2*	*6·0*	*5·7*	*6·0*	*5·5*	*5·3*	*5·1*	*5·4*
TOTAL ...	*6·2*	*6·1*	*5·8*	*6·0*	*5·5*	*5·5*	*5·0*	*5·3*

There thus appears to be little doubt that the result of the Milk Marketing Schemes has been to level out retail milk prices throughout the country. It has, however, been suggested that they have done no more than rectify a situation that was previously out of equilibrium.

The evidence presented here does not seem to support this view. In 1928-9 retail milk prices were probably not out of equilibrium.

Manufacturing prices were still in line with liquid prices, as is shown by the fact that in the summer manufacturing season the price of liquid milk under the Permanent Joint Milk Committee agreement was only 0·8d. per gallon, or 0·2d. per quart higher, at the edge of London milk sending area, than the manufacturing price. There was thus little stimulus to manufacturers to divert milk intended for manufacture in the producing areas to the liquid market, thus bringing down liquid prices in these areas.

In 1932-3 this was no longer true. Milk product prices fell sharply between 1929 and 1933, so that the price of manufacturing milk under the Permanent Joint Milk Committee agreements was 40 per cent lower in the summer of 1933 than in that of 1929. The wholesale price of liquid milk, under the same agreements, fell by only 1d. per gallon, or 7 per cent, between the years 1928-9 and 1932-3, so that the spread between the two prices, in the summer of 1933, was nearly 5d. per gallon, or over 1d. per quart. Thus there was a powerful inducement to divert milk intended for manufacture or for farmhouse cheese-making on to the liquid market, an inducement which must have brought down the liquid price generally had compulsory organization not taken place. There can be little doubt that a part of the divergence in retail milk prices in different areas in 1932-3 was due to distributors in the big consuming areas adhering to the agreed liquid prices, while those in the producing areas found it impossible to do so in the face of competition from erstwhile manufacturers. This theory is supported by the fact that, in 1932-3, retail prices were low not only in the producing areas, but also in the northern part of the Lancashire industrial concentration, where competition from producer-retailers was particularly severe.

If the position in 1932-3 be then dismissed as exceptional and unstable, a measure of the effect of the Schemes in levelling out retail milk prices is obtained by comparing 1935-6 with 1928-9. As Table 3 shows, whereas a comparatively small difference was made to retail prices in the winter, yet, in the summer, prices were 6d. per quart in nearly all towns in 1936, compared with a scatter of from 4½d. to 6½d. per quart in 1929. The result, seen by comparing Tables 1 and 4, was that, while average retail prices over the year were lower in 1935-6 than in 1928-9 in the four regions, Scotland 1 and 2, North-East England and North-West England 4, the main consuming areas, they were higher in the other areas, including the chief producing areas. Consumers in these areas have suffered from the scheme, and must continue to do so until liquid milk can be sold, both wholesale and retail, at lower prices in the surplus than in the deficiency areas.

Starting a Poultry Small Holding

THE first year of a specialised poultry small holding here described shows a precise plan carried through with marked success simply by means of capable management along familiar lines without any striking novelty, advantage or luck.

The holding is situated in the east of Scotland within ten miles of a large consuming centre and is typical of many created in recent years for intensive farming. In extent about seven acres and standing about 400 feet above sea level, it is held on a seven-year lease at a rent of £33 per annum. The equipment provided by the landlord consists of a dwelling-house with water and electricity laid on, together with a shell steading measuring 34 feet by 16 feet.

The tenant, a man with 17 years' experience in poultry farming, took over the holding on 5th February 1936. He had no stock or equipment, but had a bank balance of £212, 9s. 9d., plus a limited amount of credit which he drew on, to the extent of approximately £30, for living expenses in the first six months of the venture. His aim was commercial egg production and throughout the year the whole of the work was done by himself.

The first work on the holding was the construction of a brooder house, which he planned as well as built himself. The house, which runs north and south, measures 30 feet in length, 16 feet in breadth and six feet to the eaves. Six compartments down each side, capable of holding 50 chicks apiece, are separated by a three-foot gangway. The compartments are 6½ feet by 5 feet (except the two end ones, which are slightly larger) and are each equipped with a Putnam brooder. The Putnam brooder was chosen because it was easily and cheaply made. Each compartment is lit by four hopper windows 2 feet by 1½ foot in the walls. The proportion of glass to floor space is 1 square foot of glass to 2·8 square feet of floor. Permanent ventilation is through the roof ridge.

On 20th March 300 sex-linked chickens (Rhode Island Red × White Wyandotte) were purchased at the rate of £6 per 100 from an old-established and reliable breeder, followed by a further batch of 300 on March 27th. This number completely filled the brooder house, and it was hoped that approximately 500 pullets would be reared to maturity.

A small grain feed was given at 7.30 a.m. and dry mash hoppers were placed in each run until 4 p.m., when they were removed and the chicks received a good feed of grain. Water was before the birds the whole time.

In the meantime nine slatted-floor houses 8 × 6 feet had been constructed, the general plan in this case being taken from Bulletin No. 56, "The Housing of Poultry," of the Ministry of Agriculture. The tenant had no experience of this type of house before, but he believed that with reasonable management of the stock they would prove satisfactory, a belief completely justified by the results. A minor modification was made in the plan, baffled ventilation slits being opened at each gable end instead of in the roof, since the latter, in the tenant's view, made for too cold a house. An outside water box with a slatted floor was also fitted to give ventilation at the floor level. The houses were constructed at the rate of about one per week and approximately £3 worth of timber was used for each house. The total cost when ready for occupation, including feeding and drinking dishes was £5 per house, equivalent to 2s. per bird.

The chickens were reared intensively in the brooder house for from eight to nine weeks and were then transferred to the slatted-floor houses, 60 birds being placed in each house. Approximately 60 of the chicks proved to be cockerels and these were retained in the brooder house and subsequently fattened and sold off at the age of 13-14 weeks. Losses during the brooding period were slight, a count on September 5th showing that 495 healthy pullets were available for the winter laying season.

After the age of eight weeks a grower's mash was substituted for the chick mash previously used, and immediately the birds were transferred to the slatted-floor houses the grower's mash remained in front of them day and night as the birds were now on free range and getting abundant exercise. The grain feed now consisted of equal parts of wheat and kibbled maize and, as before, a small feed was given in the morning and a good feed at 4 p.m. When the birds commenced to lay the morning grain feed was omitted and a wet mash was provided in the middle of the day, dry mash being still always available.

The composition of the various feeding mixtures used during the year may be of interest:—

Chick-rearing Mash

21 lb.	bran.
10 ,,	alfalfa.
38 ,,	parings.
21 ,,	Sussex ground oats.
14 ,,	maize meal.
8 ,,	fish meal.
1 per cent	common salt.
2 ,,	cod-liver oil.

Grower's Mash

28 lb.	bran (or bran and alfalfa in equal parts).
42 ,,	parings.
21 ,,	Sussex ground oats.
10 ,,	maize meal.
11 ,,	meat and bone meal.

Layer's Mash

4 parts	parings.
2 ,,	bran.
2 ,,	maize meal.
1 part	fish meal.
1 ,,	Sussex ground oats.
1 per cent	common salt.

cod-liver oil in winter if needed.

Chick Grain

Finely cut wheat and maize with a small proportion of groats.

Layer's Grain

2 parts	kibbled maize.
1 part	wheat.

The first egg was laid on 12th August, and by the end of the month 376 eggs had been laid. By the end of September, when the birds were six months old, egg production had reached 34 per cent. and was steadily increasing. Thus seven months after the start the business was yielding a steady return.

Egg production month by month is set out below.

Month.	No. of eggs laid	No. of Birds
Aug. 1936	376	12th August—495.
Sept. ,,	5,034	
Oct. ,,	6,542	
Nov. ,,	5,190	
Dec. ,,	5,882	9th December—477.
Jan. 1937	7,576	
Feb. ,,	7,060	5th February—463.
Mar. ,,	9,012	

The drop in November, normally a month of low production with its short days and unfavourable weather, was ascribed principally to the exceptional storms which characterized that month. As the rapid upward rise again in production shows, however, the birds remained in excellent condition, and although many had been laying since August and September there was little neck moulting. Freedom from this common trouble was attributed to March hatching, an important point in the tenant's view, though obviously it is also due to skilful rearing. During the winter the health of the birds remained particularly good, a feature being the entire absence of colds.

Towards the end of the year a car was purchased for business purposes. It was not used for marketing, however, all the eggs being lifted by a carrier and consigned direct to retailers.

By 5th February 1937, the date on which the financial accounts were closed, the 495 pullets on the holding on 14th August, when laying began, had been reduced to 463, chiefly by culling, while a few birds were taken by foxes.

A summary of the accounts is given below:—

Balance Sheet as at 5th February 1936

Liabilities.				*Assets.*			
Capital	£212	9	9	Cash in bank	£212	9	9
	£212	9	9		£212	9	9

Capital Account for Year ending 5th February 1937

Dr.				*Cr.*			
To Personal	£58	9	11½	By Balance brought forward	£212	9	9
,, Produce consumed ...	1	10	0	,, Net Profit	127	13	11
,, Value of House ...	15	0	0				
,, Balance carried down ...	265	3	8½				
	£340	3	8		£340	3	8
				By Balance brought down	£265	3	8½

Balance Sheet as at 5th February 1937

Liabilities.				*Assets.*			
Sundry Creditors ...	£51	5	6	Stock	£226	19	9
Capital	265	3	8½	Share Capital	40	0	0
				Sundry Debtors	31	3	5
				Cash in Bank	14	12	2½
				Cash in hand	3	13	10
	£316	9	2½		£316	9	2½

Trading and Profit and Loss Account for Year ending 5th February 1937

Valuation 5.2.36		Nil.	*Valuation 5.2.37*		
Purchases			463 pullets ...	£92 12 0	
Poultry ...	£36 0 0		Equipment ...	129 9 1	
Feeding Stuffs	124 0 0		General Stores	4 18 8	
Plants	0 16 4				£226 19 9
			Receipts.		
Equipment and tools	131 5 3¼		Poultry	£8 4 9	
Car Expenses ...	14 16 11		Honey	0 6 9	
Rent, etc. ...	31 0 2		Eggs—2501 dozen	220 15 3	
Miscellaneous	27 9 10½		Grazing	9 2 6	
		£365 8 7	Miscellaneous ...	11 3 6	
Net Profit		127 13 11			249 12 9
			Consumed in House—say ...		1 10 0
			Estimated value of House ...		15 0 0
		£493 2 6			£493 2 6

Eggs laid during period 12th August 1936 to 5th February 1937—2611 dozen.

After crediting the accounts with £15 for the value of the house as a dwelling and before charging anything for the tenant's labour, the result of the year's operations is a net profit of £128. In addition to living off the business for the year, the tenant has increased his capital by approximately £50.

Since egg production was the sole aim of all the operations on the holding, other receipts being purely incidental, it is legitimate to consider the total expenditure after adjusting for the closing valuation as a charge against egg production. The total cost worked out on this basis is £138, 8s. 10d. The detailed figures are set out below.

	Total	Per dozen eggs produced *d.*	Per dozen eggs sold *d.*
Feeding stuffs*	£124 0 0	11·40	11·90
Rent and rates	31 0 2	2·85	2·98
Car expenses	14 16 11	1·36	1·42
Equipment and tools ..	1 16 2	0·17	0·17
Miscellaneous	23 7 7	2·15	2·24
	£195 0 10	17·93	18·72
Less Appreciation of Stock	56 12 0	5·20	5·43
Cost	£138 8 10	12·73	13·29
Average selling price			21·18

* Including rearing to laying stage.

During the year 144 cwt. of grain and 163 cwt. of meal were used. The value of the food used during the laying period was £86, 5s. 11d., or 7·93 pence per dozen eggs produced.

The cost per dozen eggs produced cannot be taken as representative of egg production costs on an established poultry farm, since the figures refer merely to the first year in the development of the business, during the first half of which (normally the period of greatest production) no eggs were sold. They are quoted to illustrate a remarkably successful start with limited capital.

With regard to the future the tenant does not in the meantime intend to breed, but will continue to buy in chicks, selling off the pullets at a year old. When fully equipped, he plans to keep 1000 laying birds.

Keeping the Proven Sire

THE following article is contributed by Messrs Andrew C. M'Candlish, B.Sc., Ph.D., and J. P. Struthers, B.Sc., N.D.A., the West of Scotland Agricultural College.

There may be considerable disagreement as to what constitutes a good dairy sire—in fact practically every dairy farmer has his own ideas on this problem—but almost everyone will admit that the bull which has proved to be a good sire should be kept in use as long as possible. There are difficulties in this connection however.

The first of these is in avoiding in-breeding in the small herd. The only way to overcome this difficulty is by disposing of the bull. In the larger herds, however, older bulls which have proved to be valuable breeding animals can be kept in use so long as there is in the herd any considerable number of unrelated or not too closely related females.

Another difficulty which arises in all herds is that of the temper of the aged bull. All bulls are dangerous and so the majority of farmers, to avoid the risks attendant upon the use of older bulls, dispose of their bulls after only one or two years' service.

The construction of a properly planned bull pen eliminates all risk in the keeping of an aged bull. A sketch plan of a suitable pen is given in Figure 1. It is adapted from a plan issued several years ago by the United States Department of Agriculture. A general idea of a model of this bull pen is given in Figure 2, showing the gate between the yard and the breeding rack open, while Figure 3 shows the breeding rack.

The building is 18 ft. by 12 ft. with a 6 ft. passageway at one end, thus leaving the actual pen 12 ft. square. There is a door from the outside into the feeding passage, and a door or gate from the feeding passage to the pen.

Between the pen and the outside run there is a sliding 4 ft. door which is controlled from the feeding passage by ropes or chains run on pulleys. The outside exercise yard may be of any convenient size, a suitable one being 24 ft. by 11 or 12 ft. At the end of the building there is a passage in which is situated a breeding rack. The gate is so hung that it can confine the bull to the yard or give him access to the passage containing the breeding rack. At the further end of this passage there is a gate through which the cow can be led out after service.

With this pen no one need ever be on the same side of the fence or wall as the bull. The division between the feeding passage and the pen may be solid or of metal tubing. Feeding may be carried out either with a stanchion or through some convenient aperture in the partition. One great advantage of a stanchion is that if it is desired to handle the bull he can generally be easily confined while feeding provided he is always fed there.

When it is desired to clean out the pen the bull is kept outside by means of the sliding door. At the time of service the cow is led into the breeding rack and tied, and then the gate from the exercise yard to the breeding rack is opened. After service it is closed and the cow removed.

The building may be made of any desired material, provided it is of strong construction, or an old building may be adapted for the purpose. The fence around the exercise yard should be strong. There are arguments as to whether or not it should be of solid construction, but these are unimportant so long as it is strong enough. There are possible advantages in a wood or iron rail fence so that the bull may see around him, and not be kept in solitary confinement. The lighting of the pen should be from the roof and some ventilation should also be given. Such a pen and yard allow for the control of vicious bulls without danger to the attendant.

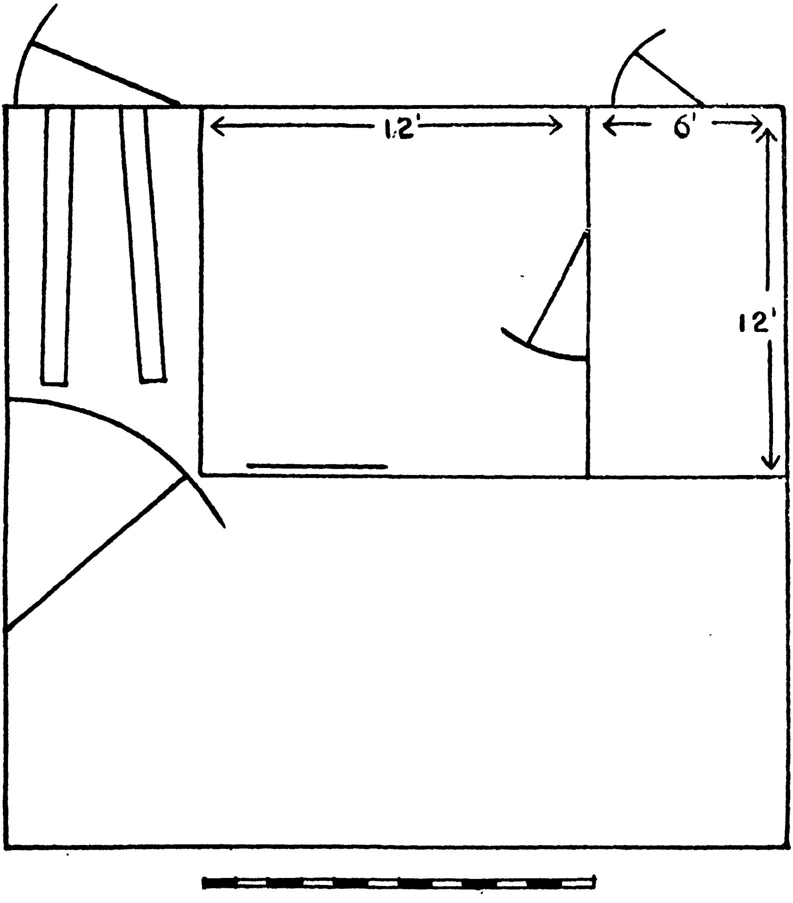


FIG. 1—Plan of a Bull Pen

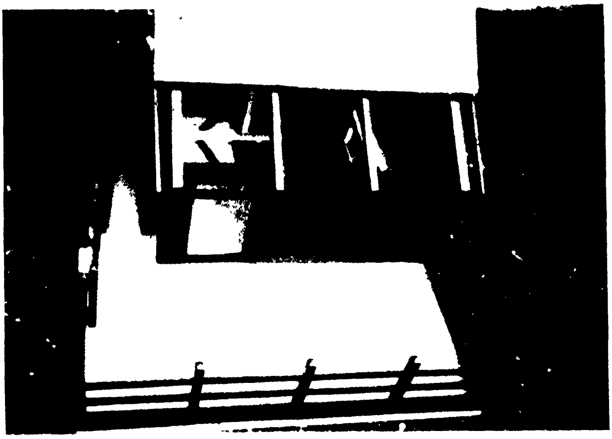


FIG. 2—Model of a Bull Pen

FIG. 3—The Breeding Rack

The Agriculture Bill

A statement of policy was made by the Minister of Agriculture in the House of Commons on 27th May, and a Bill embodying the Government's proposals was read a second time in that House on 5th July. The following is a summary of the provisions of the Bill.

Part I authorises the payment of contributions of half the cost of lime and a quarter of the cost of basic slag acquired for application to the land in quantities of not less than two tons. The scheme may provide for the case of an association of farmers, allotment holders or small holders purchasing in bulk for distribution to its members, and for enabling a farmer who produces his own lime to receive payment calculated according to a scale.

This scheme will be administered by a Land Fertility Committee, and will remain in force for three years from 1st August 1937, but may be extended by Order for two further years.

Part II contains provisions for subsidy payments on oats and barley. If in any year up to 1941 the United Kingdom prices per cwt. of home-grown oats falls short of 8s. by 5d. or more, the occupier of land on which oats or barley were produced in that year will receive in respect of each crop a payment per acre of six times the difference between the United Kingdom price and 8s., subject to a maximum of £1 per acre. No payment will be made for less than one acre of oats or barley, and odd fractions will not count.

The United Kingdom price is to be determined by the three Ministers concerned; the period over which the average is to be taken is September to March.

If the acreage of oats or barley qualifying for payment in any year after 1937 exceeds by more than 10 per cent the acreage qualifying in that year, the payments to be made will be reduced in proportion. An occupier who is a registered wheat grower will have to declare each year in respect of each area of land that he farms as a single unit whether he wishes to receive payment under the Wheat Act or payment for oats and barley; he cannot get both in respect of the same farm.

Certain amendments of the Wheat Act are made, the most important of which is the raising of the limit for full deficiency payment from 27 million cwt. to 36 million.

Land drainage is the subject of Part III. The Minister of Agriculture is empowered to make grants to drainage authorities in England and Wales, and the Department of Agriculture for Scotland to make grants to owners or occupiers of agricultural land in respect of expenditure incurred in draining it. So far as Scotland is concerned, the intention is to continue to give grants on the lines of the scheme which has been in operation in recent years, but with an increase in the rate of grant from 25 per cent to 33⅓ per cent of the approved cost.

Part IV contains provisions designed to stimulate the eradication of animal diseases. In the first place the functions of all veterinary inspectors and officers in Great Britain under the Diseases of Animals Acts, the enactments relating to milk and dairies and Section 9 of the Milk Act, 1934, are in future to be discharged by veterinary officers in the service of the Ministry of Agriculture, and provision is made for the transfer to the staff of the Ministry of officers of local authorities and of any other Government Department engaged in such functions.

Up to 31st January 1941 the Minister is empowered to make special payments to owners of herds of cattle for the purpose of securing the freedom of the herds from tuberculosis. After that time the owner of a herd that satisfies certain conditions will receive special payment from the Board administering the Milk Marketing Scheme under which he is registered.

The Minister is to receive, up to the same date, special powers of expenditure for the eradication of diseases of animals, and he is also to receive, without limitation of time, extended powers for the slaughter of animals " affected or suspected of being affected by, or having been exposed to the infection of," any of such diseases as may be specified from time to time.

He is further empowered to make an Order declaring any area to be (*a*) an " eradication " area, or (*b*) an " attested " area in respect of any particular disease, according as (*a*) a substantial majority of the cattle in it are free from that disease or (*b*) the disease is " for practical purposes " non-existent in it.

Lastly, in order to promote the breeding and distribution of stocks of poultry free from disease, the Minister may provide for persons engaged in breeding and distribution facilities for the free inspection, testing and examination of poultry, alive or dead.

Report on Rural Housing in Scotland

In January, 1936, the Scottish Housing Advisory Committee were asked by the Department of Health to furnish a report on the following terms of reference:—

" To consider the application of the Housing (Scotland) Acts and the Housing (Rural Workers) Acts to housing conditions in rural areas and to advise what action should be taken to facilitate in such areas the provision of new houses and the improvement of existing houses for the working classes, with special reference to the position of farm servants, small landholders and persons of like economic condition."

The matter was referred by the Committee to the Rural Sub-Committee who have reported on the questions raised in the terms of reference. The report has been adopted by the main Committee and is now published by H.M. Stationery Office (Cmd. 5462, price 1s. 6d.). The conclusions and recommendations of the Committee are grouped under five main heads as follows:—

(1) The general administration of the Housing (Scotland) Acts in rural areas.

(2) The Housing (Rural Workers) Acts, 1926 and 1931.
(3) Housing in villages.
(4) The housing of farm servants.
(5) The housing of landholders, cottars, squatters, statutory small tenants and similar classes.

(1) Discussing the general administration of the Housing (Scotland) Acts in rural areas, the Committee state that with the exception of the subsidy provided by the Housing (Rural Authorities) Act, 1931, the subsidies for the erection of houses for general needs which were available from 1919 to 1933 were inadequately used by County Councils of rural counties and in the absence of any direct subsidy for the purpose, County Councils of rural counties are unable at present to erect houses for the general needs of rural workers. With few exceptions County Councils are not carrying out adequately their statutory duty of inspecting working-class houses in their districts. The standard applied by most County Councils in determining whether a house is defective is stated to be too low and the desirability of a reasonable and uniform standard in this connection is stressed. County Councils of rural counties are not making sufficient use of their powers to demolish or close unfit houses or to secure their repair or improvement, while the number of houses which are being built to replace unfit houses in rural counties is inadequate, the County Councils of these counties having grossly underestimated the number of houses required for this purpose. The Committee further observe that no real attack is being made on the problem of overcrowding in rural areas, and that the subsidy of £6, 15s. under the Housing (Scotland) Act, 1935, is inadequate in many rural counties for the provision of houses to end overcrowding among rural workers and persons of substantially the same economic condition.

(2) *The Housing (Rural Workers) Acts*, 1926 *and* 1931.—In the administration of these Acts, which enable local authorities to give grants or loans to private owners for the reconstruction or improvement of dwellings to be occupied by agricultural workers or persons of substantially the same economic condition, the Committee report that there would appear to have been a grave waste of public money. According to a survey made of typical parishes only slightly more than half the dwellings dealt with under the Acts have been satisfactorily reconstructed. In terms of the Acts, Local Authorities may receive applications for assistance up to 23rd June 1938. The Committee have had considerable hesitation in recommending any extension of the Acts, but in view of the very large number of dwellings in rural Scotland which still require to be improved they recommend (four members dissenting) that County Councils should be empowered to receive applications for assistance for two years after the passing of the extending legislation. In their view there should be no subsequent extension of the Acts, and the extension recommended is only envisaged on the assumption that stringent conditions will be imposed to ensure, *inter alia*, (*a*) that no assistance will be given for the reconstruction

or improvement of radically defective houses, (*b*) that when reconstructed or improved the dwelling shall conform as nearly as possible to the requirements of the local building bye-laws, and (*c*) that, unless in exceptional circumstances, no assistance will be given towards the reconstruction or improvement of a dwelling which, after the works are carried out, will not have an inside water supply, water-closet and bath. Assistance under the Acts, it is stated, should broadly be confined to cases in which the reconstructed dwelling will contain at least three rooms. County Councils should also be empowered to given an additional grant not exceeding £50 for the addition of necessary accommodation to end overcrowding in a dwelling which before the passing of the Act of 1935 had already received the maximum assistance under the Housing (Rural Workers) Acts. The Department of Health should be empowered to pay additional Exchequer contributions under the Acts in cases where the County Council requires relief from the burden of expenditure arising therefrom.

(3) *Housing in Villages.*—The Committee were particularly impressed by the volume of evidence received indicating that there is a serious shortage of houses in villages for the general needs of the rural population, and they are completely satisfied that the erection of new houses in rural areas to meet these needs is one of the most important steps which can be taken to improve rural conditions. The classes of persons requiring houses include casual agricultural labourers, rural postmen, railway workers and blacksmiths; and special stress is laid on the need for houses for young married persons and retired farm servants. It is recommended that Exchequer assistance should be given to County Councils to erect houses for the general needs of agricultural workers and persons of substantially the same economic standing. The amount of assistance should vary according to the needs of each county; and the Department of Health should be guided by an advisory committee in determining the amount of subsidy. This Exchequer assistance would, in the case of houses erected to remedy overcrowding among rural workers and persons of substantially the same economic condition, supersede the existing subsidy under the Housing (Scotland) Act, 1935. The Committee are not in favour of any revival of the general subsidy to private persons for building in rural areas.

(4) *Housing of Farm Servants.*—The Committee have found that a very large number of farm servants' houses are defective. From a detailed survey made of three typical parishes it appeared that 40 per cent of the farm workers' houses were damp, 35 per cent had no sanitary conveniences whatsoever, and 14 per cent were beyond repair. About 70 per cent had major defects, such as dampness, absence of water and sanitary conveniences, no storage or larder accommodation, insufficient lighting, etc. The Committee are of opinion that in general no section of the population is compelled to live in such consistently bad housing conditions as farm servants. County Councils, it is stated, should be required to make a special survey of all the tied houses in their districts and to obtain from each owner of a defective house either an

undertaking that the house will be repaired or replaced or a definite statement that he cannot or will not repair or replace it. If the owner of a tied house which can be repaired will not repair it, the County Council should exercise their statutory powers to carry out the necessary work and recover the cost from the owner. If a house is unfit and cannot be repaired, it should be demolished or closed.

The Committee are of opinion that the tied house system has certain real disadvantages from the workers' point of view, and that it should be the definite aim of housing policy to reduce it to a minimum. While the erection by County Councils of new houses for the general needs of rural workers will indirectly reduce the need for tied houses, it is considered desirable to expedite the improvement of farm cottages, and to this end it is recommended (five members dissenting) that assistance should be given to owners to replace unfit houses where it is essential that the new houses should be built on the farm, on production of a certificate from the Department of Agriculture that the houses are necessary for the purposes of the farm and must be erected thereon. The assistance to private owners should be a lump sum grant of 50 per cent of the cost of the house with a maximum of £200 for a four-apartment house and £160 for a three-apartment house. Houses erected by private owners with such assistance should be equal in all respects to houses erected by County Councils and should have at least three rooms.

The Committee consider that the housing of unmarried farm workers in bothies and " chaumers " is even more unsatisfactory than that of married workers, and recommend that County Councils should be required to make a special survey of bothies and " chaumers " and to obtain from owners undertakings that defects will be remedied or definite statements that the owners cannot or will not remedy the defects. Steps should be taken to apply or, where necessary, to make applicable, the Housing (Scotland) Acts to bothies and "chaumers," and County Councils should make bye-laws dealing with the structure, furnishing and maintenance of these. It is recommended that assistance should be given to owners of unfit bothies or " chaumers " to replace them by new cottages under the same conditions as the proposed assistance for replacing unfit farm cottages, no assistance, however, being given to erect new bothies or "chaumers." In the opinion of the Committee, grants under the Housing (Rural Workers) Acts can competently be given for the improvement of bothies and "chaumers."

The Committee were unable to accept the arguments advanced for the lowering or non-application, as regards farm servants' houses, bothies and "chaumers," of the overcrowding standard contained in the Housing (Scotland) Act 1935.

(5) *Housing of Landholders, Cottars, Squatters, Statutory Small Tenants, etc.*—The Committee state that, in spite of the great improvement in the housing of landholders since 1919, many landholders are living in radically unfit houses or in houses lacking a proper water supply or sanitary conveniences. The condition of houses occupied by statutory small tenants may be taken to be

roughly similar to that of landholders' houses, while the condition of houses occupied by cottars and squatters is generally worse. On the passing of new legislation County Councils should survey houses occupied by these classes in their areas and obtain definite proposals for the repair or replacement of any defective houses. It is recommended that County Councils should be empowered to give assistance to landholders to erect new houses in place of unfit houses, such assistance to be a grant of 50 per cent of the cost, limited to £200 for a four-apartment house and £160 for a three-apartment house. Similar assistance should also be available to cottars and squatters who can obtain feus, to landlords of statutory small tenants who are of an economic condition substantially the same as that of agricultural workers, and also, subject to that qualification, to owner-occupiers of small farms not exceeding £50 in rental or 50 acres in extent.

The report is signed by the following members of the Committee:—Dr Henry Alexander (Chairman), Mr J. P. Ross Taylor (Chairman of the Rural Sub-Committee), Dr James R. Adam, Dr W. G. Clark, Mr James Cumming, Mr J. Cunnison, Miss Grace Drysdale,* Mr Joseph F. Duncan,* Bailie Wm. Elger,* Bailie Rutherford Fortune, Mr G. P. Laidlaw, Mr J. W. M'Killop, Miss Eleanor Stewart,* Lady Swan, Sir William E. Whyte, and Miss Cecil Young.*

The Harbours, Piers and Ferries (Scotland) Act, 1937

THIS Act, which received Royal Assent on 6th May, facilitates the transfer of harbours, piers or other marine works from their present owners to local authorities, sets up a new code for the construction or reconstruction or improvement of works, and makes provision for the proper maintenance and management of harbours, piers and other works. A " marine work " is defined in Section 31. It means any harbour, pier, ferry or boatslip which, in the opinion of the Secretary of State for Scotland and the Minister of Transport, is principally used or required for the fishing or agricultural industries or is essential to the maintenance of communications between the various parts of Scotland. It does not, however, include any harbour, pier or ferry vested in or worked by a railway company or any of the large harbours situated at Glasgow, Leith and the other places mentioned in the Third Schedule to the Act.

Part I of the Act deals with the transfer of harbours and other marine works to local authorities. The owner of a marine work is enabled to transfer it on agreed terms to a local authority authorised by the Secretary of State for the purpose. This means, usually, a County Council or a Town Council, but in certain cases it may be convenient for two or more Councils to combine. A power of compulsory acquisition is included in Part I, subject to proper safeguards.

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* With the reservations referred to above.

The construction or the improvement of works is equally important, and the Act aims at a simplification of procedure. For example, Sections 4 and 5, in addition to substituting the Secretary of State for the Minister of Transport as the authority to whom application is to be made under the General Pier and Harbour Act, confine the necessity for confirmation by Parliament to cases in which there is opposition to the proposals. Similarly, Section 7 gives power under which the carrying out of minor works of construction, reconstruction or improvement may in certain circumstances be authorised without any Provisional Order or legislation.

The third object of the Act is to provide for the proper maintenance of the marine works covered by Part III. This is an essential corollary to the measures which have already been described. Part III, therefore, gives the local authority or harbour authority requisite powers and at the same time deals with the financial side relating to the fixing and charging of dues, the application of the harbour revenue and the meeting of deficiencies, if necessary, out of rates.

With one minor exception the Act does not contain any provisions relating to financial aid from the Exchequer. The reason is that grants and loans can be made from existing sources, namely, the votes of the Department of Agriculture and of the Fishery Board for Scotland and the Development Fund. The question whether financial aid should be given to marine works covered by this Act will, of course, be a matter which will have to be considered on the merits of individual cases. But if in future grants or loans are given out of moneys provided by Parliament for the construction, improvement or repair of harbours or other marine works, the Government consider it to be essential, especially in view of past experience, that proper measure should be taken by the local or harbour authority to keep the work in an efficient condition and proper state of repair. Section 15, therefore, enables the appropriate Department to require the authority to carry out the operations necessary for that purpose, subject to an appeal to the Sheriff.

Part IV of the Act deals with machinery and a number of miscellaneous points. Section 24, which relates to the fixing and revision of dues on inland navigation undertakings, will enable the existing charging powers in respect of the Caledonian and Crinan Canals to be continued on their present footing. In recent years these have been continued from year to year by the Expiring Laws (Continuance) Bill.

The Sheep Stocks Valuation (Scotland) Act, 1937

SINCE 1910 the Agricultural Holdings Acts of Scotland have provided that the valuation of sheep stocks, required to be taken over from an outgoing tenant by his successor or by the landlord, shall not be subject to the rules of arbitration prescribed in these

Acts. Such valuations are therefore carried out according to the terms of the agreement between landlord and tenant, which, in many parts of Scotland, usually provides for valuation by two arbiters and an oversman. That is, each party to the transaction appoints a man of experience to represent him; if the latter disagree as to prices, the decision is referred to a third valuer, styled the oversman, who may be either mutually agreed upon or appointed by the Sheriff of the County.

In view of representations made by certain Associations that the results of valuations of sheep, especially in certain counties, had aroused a sense of mistrust and grievance on the part of those who were bound to take over and pay for sheep stocks, a Committee was appointed in November 1933 by the late Secretary of State for Scotland "to consider whether any alterations of the present methods of valuing sheep stocks in Scotland on the termination of a tenancy are desirable and, if so, what, and to report."

The members of the Committee were:—

The Right Honourable Lord Kinross, K.C. (Chairman).
The Right Honourable The Earl of Breadalbane, M.C.
Sir Iain Colquhoun, Bart., D.S.O.
Captain James Craig.
Michael G. McDiarmid, Esq.
John J. McMillan, Esq.
Sir John Maxwell Stirling-Maxwell, Bart., K.T., D.L.

The Committee made its report, which was unanimous, in September 1934.

The Sheep Stocks Valuation (Scotland) Act, 1937, which received Royal Assent on 10th June, is based on the recommendations of the Committee. It consists of five sections, of which the first three are of operative importance, the remaining two being concerned with interpretations and title.

Section 1 provides that in all cases of valuation of sheep stocks, that are bound to the ground, the arbiters shall show the basis of their valuation and state separately the amounts included in respect of acclimatisation and other factors that they have taken into account.

The Kinross Committee, after considering the evidence and views of sheep farmers, strongly recommended that the arbiter should furnish these details in his award. That has not been the practice in the past, the awards often showing only the total values placed on ewes and rams. As large sums of money are involved in these transactions the Committee considered it of manifest importance, to the incoming tenant and the landlord as well as to sheep breeders generally, to know how the total figures produced in valuations are arrived at.

The Kinross Committee recommended that this provision should apply only to valuations carried out in pursuance of leases entered into after the Bill had become law. At the same time, however, they expressed the hope that "in the case of existing leases arbiters "will voluntarily adopt the practice we have advocated. We are "strengthened in this hope by the knowledge that, almost without "exception the witnesses who appeared before us, including the "representatives of the two sheep-breeding societies affected, "expressed themselves in favour of the practice."

In view of this expression of opinion, and the fact that, as hill farm leases are normally for fourteen years, the provision if applied only to future leases would not have had general effect for a considerable time, Parliament decided that this section should apply to existing leases as well.

Section 2 enables an arbiter to obtain the guidance of the Court on any question of law that may emerge in the process of the valuation of a sheep stock carried out in pursuance of a lease entered into after the passing of the Act.

The power to seek the guidance of the Court on matters of this kind already exists for the purpose of arbitrations under the Agricultural Holdings (Scotland) Acts: but there has been no provision for similar facilities in valuations of sheep stocks.

The Kinross Committee reported that, as valuators are selected mainly because of their knowledge of sheep, they do not necessarily possess any special qualifications enabling them to determine a question of law or to place a correct interpretation on the terms of a lease or a submission made to them. Apparently the language used in such documents is sometimes susceptible of different interpretations and, in consequence, the arbiter may be in serious doubt as to the meaning of it. This section will therefore make good, as regards future leases, a defect in the existing facilities which has come to light in some valuations.

Section 2 of the Act also enables an arbiter, in cases where a submission has been made to the Court on a point of law, to make a provisional valuation in the nature of "a payment to account," the amount of which would normally be paid over to the tenant at his outgoing. The purpose of this provision is to obviate hardship to an outgoing tenant who has handed over his stock but cannot receive full payment for it until the Court has given its finding on a question of law and thereafter the arbiter has made his final award. The terms of the sub-section secure that the amount of the provisional valuation will be within the total amount that is certain to be found due.

Section 3 enables the Land Court to act as valuers of sheep stock either under current or future leases if both parties to the valuation agree.

The Kinross Committee in their Report made no recommendation on this subject, but they expressed the view that if Parliament saw fit to empower the Land Court to act as arbiters in sheep stock valuations, for parties who so agree, their actings would command respect. Already the Court have power in the same circumstances to act in agricultural arbitrations.

Farm Wages in Scotland

THE Department issued, as usual, with their Monthly Agricultural Reports for 1st January and 1st July supplements giving tabular statements of the estimated cash wages and value of perquisites given to the various classes of farm workers at the Martinmas and Whitsunday terms. These statements are summarised in this article, together with comparisons with the rates current at Whitsunday 1936.

The pecuniary values of the allowances given, in addition to cash wages, as reckoned at each of the three terms mentioned above, are as follows:—

	Whitsunday 1936	Martinmas 1936	Whitsunday 1937
Meal, per cwt.	15s. 4d.	15s. 4d.	15s.
Milk, per gallon . . .	1s.	1s.	1s.
Potatoes, per ton . . .	£3, 10s.	£3, 10s.	£3, 12s. 6d.
Coal, per ton	£1, 15s.	£1, 15s.	£1, 15s.
House, per annum . . .	£6	£6	£6
Board and lodging for single men, per week . . .	14s.	14s.	14s.
Bothy accommodation, with attendance, per annum .	£9	£9	£9
Bothy accommodation, without attendance, per annum .	£6	£6	£6
Keep of cows and followers, per cow, per annum .	£10	£10	£10

The only items which show changes in estimated value as compared with last year are oatmeal and potatoes. The average wholesale price per cwt. for oatmeal for the ten years ended 31st December 1936 was 15s., while the average price for ordinary ware potatoes paid to growers for the same period was £3, 12s. 6d. per ton. In the case of oatmeal the long-term average price is below the value put on the perquisite at Whitsunday 1936 by 4d. per cwt., while the value of potatoes has been raised by 2s. 6d. per ton.

The arithmetical averages of the Department's figures for the wages of married men are as follows:—

Average Weekly Earnings of Married Men

	Summer, 1936			Winter, 1936-37.			Summer, 1937		
	Cash	Allowances	Total	Cash	Allowances	Total	Cash	Allowances	Total
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Ploughmen	26 9	7 9	34 6	27 2	7 9	34 11	28 7	7 9	36 4
Cattlemen	27 10	7 11	35 9	28 8	7 10	36 6	29 10	7 10	37 8
Shepherds	26 7	9 5	36 0	27 3	9 6	36 9	28 6	9 5	37 11

The total weekly earnings of each class show an increase of nearly 2s. as compared with those returned at Whitsunday 1936.

Married Ploughmen.—The following table gives in round figures the weekly earnings of married ploughmen in summer 1937 as compared with summer 1936, in respect of 38 out of a total number of 49 counties and parts of counties in the Department's wages statement:—

County or District	Summer, 1936			Summer, 1937		
	Cash	Allowances	Total	Cash	Allowances	Total
	s.	s.	s.	s.	s.	s.
Wigtown	24½	15	39½	25	15	40
Kirkcudbright	29½	4	33½	29½	4	33½
Dumfries	32	3	35	33½	3½	37
Selkirk	27	5	32	30	5	35
Roxburgh	27	5	32	30	5	35
Berwick	29	5	34	32	5	37
Peebles	32	3½	35½	35	4	39
East Lothian	30	3½	33½	32½	3½	36
Midlothian	31½	3	34½	34	3	37
West Lothian	32	3	35	34	3	37
Stirling	36	6½	42½	37	6½	43½
Dunbarton	37	3	40	38	3	41
Lanark (N.W.)	35	4	39	36	4	40
Renfrew	35	3½	38½	37½	3½	41
Ayr (N.)	34	5	39	36	5½	41½
Ayr (S.)	33½	3½	37	36	4	40
Lanark (S.E.)	30	4	34	32	4	36
Clackmannan	32	3	35	33½	3	36½
Fife (S.W.)	32	3	35	33½	3	36½
Fife (N.E.)	25	8	33	27	8½	35½
Kinross	24	10	34	25½	10½	36
Perth (S.E.)	25	10	35	25	10	35
Perth (Central)	26	10	36	27½	10	37½
Angus (S.W.)	26½	9½	36	29½	9½	39
Angus (N.E.)	25	11	36	26½	11	37½
Kincardine	23	10½	33½	25½	10½	36
Aberdeen (E.)	20	10½	30½	23	10½	33½
Aberdeen (N.E.)	20½	11	31½	23	11	34
Aberdeen (Central)	21	10	31	22½	10½	33
Aberdeen (S.W.)	22	10½	32½	24	10½	34½
Aberdeen (N.W.)	21	9½	30½	22	10	32
Banff (N.E.)	21½	9½	31	23	9½	32½
Moray	21	11	32	22	11	33
Nairn	19	11	30	20½	11½	32
Inverness (E.)	19	11	30	20½	11½	32
Ross and Cromarty (E.)	18½	11½	30	20½	11½	32
Sutherland	18½	13	31½	20	13½	33½
Caithness	16	14½	30½	16½	14½	31
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Average	26 7	7 7	34 2	28 5	7 8	36 1

The arithmetical average of the cash wages for these 38 areas is higher than last year by 1s. 10d., while the value placed on the allowances or perquisites is higher by 1d. In Peebles, Selkirk, Roxburgh, Berwick, South-West Angus and East Aberdeen the cash wage has advanced by 3s. per week, and in Renfrew, South Ayr, East Lothian, Midlothian, Kincardine and North-East Aberdeen by 2s. 6d. per week, while in twenty-four other districts advances ranging from 6d. to 2s. have taken place and two districts show no change.

The range of the total wages, including cash and allowances, in the various divisions of the country, is as follows:—In the southern counties from 33s. 7d. to 40s.; in the Lower Clyde Valley from 39s. 9d. to 41s. 1d.; in the remainder of the central area from 35s. to 43s. 6d.; and in the north-eastern and northern counties from 31s. to 39s.

Single Ploughmen.—The average wage of single ploughmen in the south-eastern counties is 31s. 3d., or 1s. 3d. more than last year. In the south-western districts wages vary from 27s. 10d. in Dumfries to 32s. 6d. in South Ayr. In the Lower Clyde Valley and North Ayr the cash wages average 18s. 6d. as compared with 15s. 7d. a year ago, with board and lodging valued at 14s. The average cash wage in the east-central division is 25s. 9d., an increase of 3s. 7d. on last year's figure, while the allowances, valued on the average at 6s. 3d., remain unchanged. In the northern and north-eastern counties the average cash wage is 20s. 9d., and the value of the perquisites 12s. 10d. In Scotland as a whole a single ploughman's wage is 31s. 10d., showing an increase of 2s. 9d. as compared with Whitsunday 1936.

Dairy Workers.—Where dairy workers live on the farm the prevailing remuneration, including the estimated value of their board and lodging, ranges from 24s. in Orkney to 35s. 2d. in Central Aberdeen, the average figure being about 30s. 6d. In East Lothian and Midlothian, where remuneration is wholly in cash, 23s. 6d. to 26s. 6d. per week is paid.

Women Workers.—Rates for other women workers, including board and lodging or their equivalent, vary between 21s. 10d. in Caithness and 32s. 6d. in Kincardine. In the Lothians and Peebles, where remuneration is wholly in cash, women receive from 20s. to 25s. 6d. per week. Women paid by the day generally receive from 3s. to 4s.; in Wigtown, however, the wages paid range from 2s. to 3s., in Stirling from 3s. to 5s., in Ross mainland from 4s. to 4s. 6d., while in Moray and South-West Angus 4s. 6d. per day is paid. Women paid by the hour generally receive from 5d. to 7d.

Boys.—The wages paid to boys vary considerably according to ability and experience. Where they are engaged for a period of six months and receive cash wages in addition to board and lodging the total weekly remuneration ranges generally between 20s. and 27s. Where cash wages only are paid the rate generally varies between 12s. and 20s.; some boys, however, receive only 10s. and others as much as 26s. 6d.

Girls.—In Kirkcudbright, Midlothian and West Lothian girls receive from 12s. to 19s. 6d. per week. Where board and lodging are provided the estimated total weekly remuneration varies from

18s. 4d. to 30s. 11d. In North-East Angus and East Lothian girls are paid 3s. 6d. per day.

Casual Workers.—Men are usually paid from 4s. to 7s. per day; in a few cases up to 8s. per day is paid. Occasional workers of a skilled class in Roxburgh and Selkirk receive from 6s. to 8s. per day. Where engagements are made from week to week, men's wages vary between 22s. and 40s., while men paid by the hour receive from 6d. to 1s. Women casual workers in Ayrshire are paid at rates ranging from 6d. to 9d. per hour.

Reviews

British Grasses and their Employment in Agriculture. S. F. Armstrong, M.A. (Third Edition) Pp. 350. Cambridge University Press, 1937. 15s.

Grasses and grasslands have long suffered owing to a serious lack of exact information in an available form. This doubtless explains to a certain extent why the great economic importance of grassland in British agriculture is not yet fully realised. "British Grasses" was originally published in 1917. Previous to this, Marshall Ward's "Grasses," M'Alpine's very useful little book on the "Identification of Grasses" and Hutchinson's "Handbook of Grasses" were the only British books available to the student apart from the sections on grasses in Percival's "Agricultural Botany." The most important feature in "British Grasses" is the information given on what may be termed the natural history of those grasses which are of importance to the farmer. There are many other important aspects of the subject, but a knowledge of the life-history and distribution, or general ecology, of these grasses is indispensable both to those who advise farmers and to all who farm. This new edition is really a new book. It might be justly called a monograph on grasses from the farmer's point of view. In the old edition the botanical description of species occupied pages 51-132; in the new edition it has increased by 21 pages. The agricultural section is virtually a publication in itself and contains not only new but the most recent information on the subject. It is nearly three times the size of the section in the old edition. "Commercial, Indigenous and New Strains," "Laying down Land to Grass," "Grassland Management," "The Conservation of Herbage," "The Improvement of Poor Grassland" and "Lawns and Greens: Their Formation and Maintenance" are all new chapters.

This is indeed a book which every student of agriculture must read and should possess, and no progressive farmer should be without a copy. It is not dear at 15s., for it covers every aspect of the subject, contains nearly 200 fine illustrations, and is printed and bound in a most attractive style.

Leguminous Forage Plants. D. H. Robinson, B.Sc., Ph.D., N.D.A. Pp. 119. London. Edward Arnold & Co. 6s.

This book fills in another gap in the literature of Agricultural Botany. Apart from Emeritus Professor Percival's "Agricultural Botany," there was no book dealing with leguminous plants used by the farmer. Text-books of Agriculture gave information as well as a few less-known publications, but none of these dealt fully with legumes. A very valuable feature of the book is the fine black and white drawings. Those illustrating the seedling and other stages of many of the plants are invaluable to students and others. Each plant is described and carefully illustrated. The seed, seed production, and chemical composition are all considered. A useful table of seed statistics and two pages of seed illustrations are given. In addition, there is a useful glossary and an index. The book is clearly printed, is of a convenient size, and—a very important point—well bound. The price of 6s. is very reasonable. It is a book which can be thoroughly recommended and is complementary to the new third edition of Armstrong's "British Grasses."

The Pests of Fruits and Hops. A. M. Massee, D.Sc., F.R.E.S. Pp. 294. London. Crosby Lockwood & Son, Ltd., 1937. 15s.

It is twenty-eight years since the publication of Professor Theobald's "Insect Pests of Fruit"; consequently Dr Massee's book fills a serious gap in entomological literature. Dr Massee is well known to the horticultural public and his work is supported in a foreword by Mr J. C. F. Fryer, Director of the Ministry of Agriculture's Plant Pathological Laboratory.

Though written primarily for the fruit-grower, this work will also prove invaluable to the horticultural advisory officers and students. The subject matter is presented in a thorough yet readable form and is well supported by excellent photographic plates, most of them supplied by Mr R. M. Greenslade, Assistant Entomologist at East Malling. Particular attention is paid to host symptoms, recognition of pests and methods of control. Scientific descriptions are reduced to a minimum.

The chief fruit parasites are considered in detail, while the less-known parasites have not been neglected; references to further information are given throughout the book. The reader may think that undue attention is devoted to the pests on Apple, but it must be remembered that many of these occur also on other fruits, though they are only described upon one host. The greater portion of the book is equally useful to fruit-growers in Scotland and in England, since Apple, Strawberry, Currants, Plum, Pear, and Raspberry are the principal fruits discussed.

There is a valuable chapter on insecticides, embodying the results of recent research on such washes or sprays as tar-distillates, petroleums, nicotine and lime-sulphur. Particular attention is given to the reactions of different fruit varieties towards certain sprays.

Mr Turnbull of the Ministry of Agriculture contributes a very useful chapter on equipment and methods of spraying. Another chapter concerns beneficial insects and provides interesting reading.

This book can be recommended with confidence to the practical grower as well as to the advisory officer and horticultural student.

Proceedings of the International Conference of Agricultural Economists—Fourth Conference, 1936. Pp. 528. London. Oxford University Press, 1937. 17s. 6d.

In the issue of this JOURNAL for January 1937 an account was given of the proceedings of the Fourth International Conference of Agricultural Economists, held at St. Andrews between 30th August and 6th September 1936.

There has since been published the volume of which particulars are given above, containing the text of some 30 papers, with discussion in many cases. The programme of the Conference covered a wide range of subjects—the relations of agriculture to industry and to the community; the relations of land tenure to the economic and social development of agriculture; the provision of agricultural credit; commercial policy and the outlook for trade in agricultural products; farm organisation; marketing; consumption of agricultural products; part-time holdings for urban workers; and some special subjects of minor importance. Including the readers of papers, some 70 members of the Conference took part in the discussions, representing 17 countries, and exhibiting among them a great volume of expert knowledge. On the more important subjects full discussion took place, with a lively interchange of views in some cases, particularly where national policy was involved. Light is thrown on many of the problems that confront farmers and administrators at the present time. It cannot be said that this book will solve these problems for them. It contains, however, a substantial contribution to the discussion of many questions of the first importance, and it should receive the attention of all who are seriously interested in the future of agriculture.

A word of praise should be added for the manner in which the editorial work has been carried out by Mr J. P. Maxton and his assistants, and for the handsome style in which the volume has been produced by the Oxford University Press.

The Agricultural Register, 1936-7. Pp. 325. Oxford. The Agricultural Economics Research Institute, 1937. 5s.

The fourth issue of the Register will receive as warm a welcome as did its predecessors from all who are concerned with argicultural affairs. Its plan is now well known, and the only marked change that has been made in this issue is a skilful re-arrangement and compression of Chapter VI, "Supplies and Prices," to which is mainly due the reduction in the size of the volume from 407 to 325 pages. The introduction contains a brief but suggestive discussion of the circumstances that led to the adoption in 1931 and the following years of a new agricultural policy. There is an error of dating on page 1. It was not during the summer, but at the end of October 1936, that Mr Elliot became Secretary of State for Scotland.

The Rabbit in Australia. David G. Stead. Sydney. Agents for Great Britain—The University of London Animal Welfare Society, 42 Torrington Square, London, W.C. 1. Price 2s., post free 2s. 2d.

"There are two ways by which we can produce more wool. Firstly, to make the grass carry more sheep; and, secondly, to make our sheep carry more wool." This dictum of a prominent grazier in Australia is equally true for Scotland. In Australia it is reckoned that five rabbits usurp the place of one sheep. Rabbits starve the holding and starve the sheep and lambs. This grazier concluded as follows:—"Let us have more sheep and more grass; but we cannot do that without fewer rabbits." This also must apply to Scotland.

Mr D. G. Stead, the author of "The Rabbit in Australia," has had unique opportunities to study that rodent, and its ways, throughout that continent. Besides having been Special Rabbit Menace Enquiry Commissioner to the Government of New South Wales, he was also President of the Naturalists' Society of New South Wales, and of several other kindred societies. His book gives the result of his experiences in dealing with the rabbit menace and is therefore worthy of consideration where the destruction, and eradication, of rabbits is desired.

Mr Stead avers that trapping, poisoning, infecting with the germ of a contagious disease and every other method that has been tried in Australia is valueless for the extermination of rabbits. Gassing with cyanide is the only method by which success can be secured. In that country, however, holdings are protected and surrounded by wire netting fences, so that if all the rabbits within the fence are killed the land remains free from infestation so long as the fences are kept in good order.

In Scotland it is impossible to use poison for the destruction of rabbits, and trapping will never eradicate them. The experience gained at Keoldale, Durness, last year proves that rabbits can be eradicated, quickly and easily, over a large area provided that the land cannot be re-infested from adjacent country. Had rabbit-proof fences been erected around the area gassed that area would still be free from infestation with rabbits. If any further attempts are to be made to eradicate these vermin from a restricted area, the area should first be surrounded by a rabbit-proof fencing. The wire should be 42 inch by 1¼ mesh and 17 gauge, "A" grade.

In Australia one rabbit fence is 696 miles long, another 350, but these fences are ineffective because they are not looked after properly. In Australia steel posts have been found to be cheapest not only because they resist bush fires, but also because they last longer underground. The same reasons would probably apply in Scotland. Mr Stead favours each land-holder controlling his own fencing. This would not be suitable in this country because of the comparatively small size of the holdings.

The desiderata of any measure for the extermination of any animal are (1) that it should kill quickly and as humanely as possible, (2) that it should take as short a time as possible to apply, and (3) that the cost should be low.

These three requisites are fulfilled by the use of cyanide in gassing rabbit burrows; the burrows become traps in which the vermin are destroyed.

Calcium cyanide was first used in Australia in 1923 by Professor Quayle for the destruction of rabbits and in Scotland in 1925 for the destruction of rats.

The cost of gassing in Australia is said to be between 6d. and 9d. per acre.

The Countryman. J. W. Robertson Scott, Idbury, Kingham, Oxford. Quarterly. 2s. 6d.

Ten years ago (July 1927) there appeared in this JOURNAL a review of the first number of Mr Robertson Scott's quarterly magazine. The hope then expressed that his enterprise would be rewarded by a substantial circulation has been fulfilled. The magazine has grown not only in circulation, but in size. In 1927 the average number of pages of reading matter was 78. Now it is over 200, while advertisements fill nearly the same number. The price is unchanged and the magazine has retained its particular quality. It deals with country life from every conceivable point of view and enlists the services of numerous contributors, named or anonymous, of all kinds, whose common interest is love of the countryside. Special features of the April number are a set of eight photographs by Mr G. Bernard Shaw, and an article by Mr Ramsay MacDonald on a tour in lowland Scotland, with a delightful snapshot of the writer and Sir Maurice Hankey.

The following reports, prepared by the Imperial Economic Committee, have recently been published, and may be obtained from H.M. Stationery Office, 120 George Street, Edinburgh (and other addresses), at the prices stated:—

Meat. Price 2s. 6d. or 2s. 9d. post free.—This is a summary of the figures of production and trade relating to beef, mutton and lamb, bacon and hams, pork and canned meat, and also of live cattle, sheep and pigs, during the period 1929 to 1935. The tables strikingly illustrate the importance of the United Kingdom as an importer of meat of all kinds. World trade in meat as a whole declined by about 12 per cent between 1929 and 1935, but the proportion imported into the United Kingdom was more than maintained. In the same period, home production of beef and veal increased by over one million cwt., and in 1935 constituted 52 per cent of requirements as compared with 48 per cent in 1929; the output of pig meat rose from 39 to 50 per cent, while that of mutton declined from 46 to 43 per cent. The share contributed by Empire countries showed in all cases a large increase.

Dairy Produce. Price 2s. 6d. or 2s. 8d. post free.—The most striking fact here recorded is the large general increase in the consumption of, and the amount of world trade in, butter between 1929 and 1935, associated with the heavy fall in price that lasted until 1934. International trade in cheese and eggs on the other hand was considerably reduced. Imports of eggs into the United Kingdom were reduced by over 20 per cent, while production is estimated to have increased by one-third between 1929 and 1934.

Fruit. Price 2s. 6d. or 2s. 8d. post free.—Changes in the world output of the different kinds of fruit are difficult to measure over short periods, but there has certainly been a large increase in recent years, particularly in citrus fruits, bananas, and canned fruits of various kinds. A distinctive feature of the United Kingdom trade has been the marked growth of the imports from Empire countries, which in 1935 were over seven times greater than in the years before the war.

Industrial Fibres. Price 2s. 6d. or 2s. 9d. post free.—This report covers wool, cotton, silk, flax, hemp, jute and rayon. The British Empire accounts for nearly half the world's wool production, Australia alone producing more than one-fourth of the total. It is significant to note that three of the largest producers of rayon, Japan, Italy and Germany, are countries that are particularly dependent on foreign sources of supply for their textile raw materials. The recent work done in Germany and Italy in the production of artificial wool lies outside the scope of this report.

Rubber and Agriculture Series—Bulletins 1 *to* 7. The Rubber Growers' Association Inc., 19 Fenchurch Street, London, E.C. Free on application.

The recent innovations and expansion in the application of rubber in Agriculture are reviewed in this series of five bulletins issued by the Rubber Growers' Association.

Bulletin 1. *Pneumatic Equipment for Farm Tractors.*—This publication discusses the technique of managing the pneumatic tyres in order to obtain the most satisfactory results. The author provides summaries of the findings of official tests both in this country and in America.

Bulletin 2. *Pneumatic Equipment for Horse-drawn Vehicles.*—Evidence from trials indicate unqualified benefits from the adoption of pneumatic tyres for this purpose. The author recommends greater standardisation of types and construction of farm carts.

Bulletin 3. *Rubber for Roadless Tractors and Trailers.*—The use of rubber in the construction of track units has considerably reduced the amount of wear commonly associated with this unit in the steel pin jointed type.

Bulletin 4. *The Care and Cleaning of Milking Machines.*—The production of a rubber resistant to the severe sterilization conditions and action of milk, providing proper care is taken, has increased the popularity of milking machines. The publication discusses the best method of handling the rubber parts in order to ensure cleanliness.

Bulletin 5. *The Uses of Rubber in Stable Management.*—This publication reviews the numerous applications of rubber in stable management with the object of securing greater efficiency and comfort and the reduction of disease.

Bulletin 6. *The Uses of Rubber in Commercial Horticulture.*—Besides showing pneumatic tyres for tractors, sprayers, trolleys, etc., this bulletin illustrates rubber pads for tree ties, fittings for cloches, and parts for grading machines, and suggests the use of cellular expanded rubber for insulation in fruit stores.

Bulletin 7. *Modern Equipment for the Poultry Farm.*—Folding units, water-carriers, etc., may be fitted with pneumatic tyres; rubber tubing aids the supply of water and the gassing of vermin; tough rubber sheathing may be used for power and lighting cables; and nest boxes may be fitted with rubber covers.

Tuberculosis (Attested Herds) Scheme

The number of attested herds in Scotland at 31st May 1937 was 395, comprising 31,913 animals. The table on pp. 808 to 311 gives particulars of the 116 herds attested in March, April and May.

The following table gives the location of the herds in counties:—

Aberdeen	5	Brought forward	288
Angus	2	Kirkcudbright	19
Argyll	3	Lanark	38
Ayr	214	Midlothian	7
Berwick	1	Nairn	1
Bute	13	Peebles	1
Dumfries	39	Perth	5
Dunbarton	7	Renfrew	14
East Lothian	1	Stirling	11
Fife	2	West Lothian	3
Kincardine	1	Wigtown	8
Carry forward	288		395

MILK ACT, 1934

TUBERCULOSIS (ATTESTED HERDS) SCHEME

LIST OF 116 HERDS ADDED TO REGISTER OF ATTESTED HERDS BETWEEN 1st MARCH AND 31st MAY 1937

COUNTY	Name of Owner of Herd	Address of Premises on which Herd is kept	Date from which Certificate of Attestation was valid	Breed or Breeds of Cattle comprising the Herd	No. of Animals in the Herd at Date of Attestation.
ARGYLL . . .	Thomas Rae Nicolson	Corra, Millhouse, Tighnabruaich .	10th March 1937	Ayrshire	90
AYR	George Crawford Allan . . .	Southridgehill, Beith	16th Jan. 1937	,,	71
	Andrew Anderson	Clinchyard, Hurlford	16th Feb. 1937	,,	53
	John Archibald	Hacks of Auchenmade, Kilwinning	3rd Feb. 1937	,,	78
	Matthew Steel Auld	West Plann, Crosshouse . .	21st Dec. 1936	,,	61
	Allan Barr	Hobsland, Monkton	27th April 1937	,,	146
	James Barr	East Whitelee and Byrahill, Stewarton	23rd April 1937	Mainly Ayrshire	87
	James Bell	No. 9 Auchenwynd, Maybole . .	9th May 1937	Ayrshire	33
	Mrs Jane Brown	Lauriston, Hollybush . . .	23rd Jan. 1937	,,	81
	Robert William Brown . . .	Kirkhill of Barnweill, Craigie . .	5th May 1937	,,	64
	James Bryson	Braehead, Mauchline . . .	11th March 1937	,,	92
	Andrew and Robert Craig . .	Ryesholm, Dalry	2nd May 1937	,,	93
	Donald Cross	Knockdon, Maybole	25th Jan. 1937	,,	160
	William Currie	Knockrochar, Dailly, Girvan . .	11th April 1937	,,	70
	James Donald	Blindburn and Dalgain, Sorn, Mauchline	16th Feb. 1937	,,	95
	Mrs Agnes Drennan	Brewlands, Symington . . .	14th April 1937	,,	50
	Robert Howie Dykes	Laigh Hillhouse, Troon . . .	14th March 1937	,,	66
	Andrew, Alexander and Gilbert Eccles	Low Pinmore, Maybole . . .	14th April 1937	,,	48
	John Fleming	Dykes, Cumnock	25th April 1937	,,	46
	John Halliday Foster . . .	Kames, Muirkirk	22nd Dec. 1936	,,	66
	Mrs Lilias Garven	Dalmusternock, Fenwick . . .	6th April 1937	,,	14
	Mrs Christina Gemmill . . .	Aitkenhead, Fenwick	9th Feb. 1937	,,	62

Hannah Dairy Research Institute	Kirkhill, Ayr	2nd April 1937	,,	86
David and Matthew Hastings	North Boig, New Cumnock	21st April 1937	,,	71
Robert Howatson	Castlehill, Galston	11th May 1937	,,	40
Rt. Hon Jean, Countess of Inchcape, per H. J. Hewetson, Factor	Auchencrosh, Ballantrae	24th April 1937	,,	45
Mungo Lennox Jamieson	Langholm, Ochiltree	23rd Feb. 1937	,,	78
Andrew and James Kelso	Hill o' Beith, Beith	16th Jan. 1937	,,	72
Matthew Kerr	Woodhead, Newmilns	20th March 1937	,,	88
William Kirkpatrick	Stoopshill, Dalry	16th Jan. 1937	,,	78
James and William M'Lanachan	Barshare, Cumnock	23rd March 1937	,,	111
John Lamont	Low Wardneuk, Prestwick	30th April 1937	,,	86
Misses Janet and Janie Lindsay	Oslie Brae, Stewarton	15th April 1937	,,	74
Andrew Logan	Southcraig, Hollybush	3rd April 1937	,,	78
William Kidd Logan	Laigh Dykehead, Dalry	22nd March 1937	,,	31
Thomas Howie Loudoun	Dykescroft and Fairfield, Darvel	23rd Jan. 1937	,,	95
Archibald Lymburner	Little Heateth, Auchinleck	13th Jan. 1937	,,	63
George M. M'Ghee	Craigbrae, Straiton, Maybole	2nd March 1937	,,	18
Thomas MacMillan	Whitesmuir, Skares, Cumnock	5th Feb. 1937	,,	9
Mrs Eliz. Mair and Wm. Mair	Floors, Kilmaurs	11th May 1937	,,	74
James M'Kean Martin	Blanefield, Maybole	27th Feb. 1937	,,	101
James Montgomerie	Kirkbride, Maybole	16th March 1937	,,	68
George Prentice	Raithhill, Ayr	13th April 1937	British Friesian	125
Robert Robertson	Shawwood, Tarbolton	1st April 1937	Ayrshire	48
Stuart and Murdo Robertson	Milreoch, Hollybush	22nd April 1937	Mainly Ayrshire	86
James Symington Ross	Littlehill, Hurlford	27th April 1937	Ayrshire	80
David Sillar	Low Todhill, Kilmarnock	28th Feb. 1937	Ayrshire and Ayrshire Cross	47
William Lang Smillie	Monkwood Mill, Maybole	9th April 1937	Ayrshire	52
Hugh Smith	Holmbyre, Dalry	6th May 1937	Mainly Ayrshire	106
James Smith	Sunnyside, Kilmarnock	1st April 1937	Ayrshire	25
Miss Marion C. Stirling and Hugh Stirling Young	Burnbrae, Symington	24th Jan. 1937	,,	94
Alexander Struthers	Boylston, Cumnock	14th April 1937	,,	57
William Struthers	Cauldhame, Dunlop	4th Feb. 1937	,,	73
David Wallace	South Auchenbrain and Davidston, Mauchline	30th April 1937	,,	176
Hugh Wallace	Clydenoch, Ochiltree	9th March 1937	,,	68
William Watson	Muirston and Bogside, Mauchline	1st April 1937	,,	108

REGISTER OF ATTESTED HERDS—*continued*

COUNTY	Name of Owner of Herd	Address of Premises on which Herd is kept	Date from which Certificate of Attestation was valid	Breed or Breeds of Cattle comprising the Herd	No. of Animals in the Herd at Date of Attestation.
AYR (*contd.*)	John Welsh	Passford, Darvel	18th Oct. 1936	Ayrshire	31
	George Young	Aitkenbrae, Prestwick	19th Feb. 1937	,,	146
	Mrs Hannah Young	Mid Heillar, Sorn	30th April 1937	,,	72
	Mrs Margaret Young	Low Wexford, Symington	27th April 1937	,,	60
BUTE	Robert Mackay	Bruchag, Rothesay	31st March 1937	,,	98
	William Hunter	Upper Ettrick, Rothesay	14th March 1937	,,	46
DUMFRIES	James Burgess	Lochpark, Lochmaben	10th Feb. 1937	Mainly Ayrshire	43
	John Gibson & Sons	Archwood, Lockerbie	23rd March 1937	Ayrshire	79
	William Hendrie	Castlehill, Thornhill	4th April 1937	,,	87
	John Johnstone	Millantae, Lockerbie	8th May 1937	,,	82
	Mrs Ida Wynifred Keswick	Bellfield, Summerfield and Mid Crossleys, Holywood	5th Jan. 1937	,,	55
	Mrs Janet Lamberton	Kirkcudbright, Moniaive	12th Feb. 1937	,,	40
	John Y. Lethardy	Conrick, Sanquhar	12th Feb. 1937	,,	51
	William M'Kay	Swordwellrigg, Annan	28th March 1937	,,	47
	Mrs Mary Jamieson Nicholson	Banks, Lockerbie	20th April 1937	,,	46
	James Shanks	Nutholm, Lockerbie	13th March 1937	Mainly Friesian	74
	Mrs Margaret Spence	Cowdens, Lockerbie	21st Jan. 1937	Ayrshire	97
	Robert and Alexander Weir	Drumcruilton, Durisdeer	18th Feb. 1937	,,	119
	John and John White	Balstack, Lockerbie	20th April 1937	,,	70
	John Woodburn	Castlemilktown, Lockerbie	23rd April 1937	,,	147
	David and George Dunlop Wyllie	Hannah, Cummertrees	13th Feb. 1937	,,	131
FIFE	James Hamilton	Urquhart Farm, Dunfermline	18th March 1937	,,	65
KIRKCUDBRIGHT	James Farish	Meikle Culloch, Dalbeattie	28th April 1937	Ayrshire and Jersey	107
	Wm. Pollock Gilmour and John M'Myn Gilmour	Balmangan, Borgue	17th Feb. 1937	Ayrshire	134
	Wm. Muir Grierson	Pulcree, Gatehouse of Fleet	14th Feb. 1937	,,	78
	Alexander Hogg	Upper Senwick and Millhall, Kirkcudbright	13th April 1937	,,	131
	John Hogg	Bridgend of Kildarroch, Borgue	22nd April 1937	,,	16
	James Wallace	Balgreddan, Kirkcudbright	9th March 1937	,,	185

LANARK	Walter Adamson	Harleyholm, Biggar	15th April 1937	,,	94
	J. A. and W. Brown	Cormiston Towers, Biggar	6th April 1937	,,	92
	John Cadzow	Craighead, Carluke	30th April 1937	,,	61
	James Elder	Ampherlaw, Carnwath	11th Jan. 1937	,,	63
	Thomas Fleming	Millburn, Dalserf	24th March 1937	,,	94
	William Fleming	Auldton, Dalserf	13th April 1937	,,	109
	Christina and James Gilchrist	Low Drumclog, Strathaven	12th March 1937	,,	85
	John Howatson	Dalzell Home Farm, Motherwell	26th March 1937	,,	147
	James Greig Kedar	Netherfield Dyke, Strathaven	4th May 1937	Ayrshire and Friesian	79
	Robert Reid	Greathill, Strathaven	26th March 1937	Ayrshire	72
	Thomas Scott	Netherhall, Sandilands	15th Feb. 1937	,,	67
	John Spier, Limited	Heatheryknowe and Netherhouse, Bargeddie	30th April 1937	,,	196
	Thomas Steele	Over Kypeside, Kirkmuirhill	31st March 1937	,,	72
	Archibald Weir	Netherfield, Coalburn	20th April 1937	,,	37
MIDLOTHIAN	Cockburn Farm Company (per A. D. Buchanan Smith)	Cockburn, Balerno	21st Feb. 1937	Mainly Ayrshire and Jersey	152
PERTH	Kerr & Cawder, Ltd.	Keir Home Farm, Dunblane	20th March 1937	Ayrshire	150
RENFREW	Allan Carruth	Callochant, Kilbarchan	17th March 1937	,,	64
	Robert Donald Carruth	High Auchensale, Kilbarchan	16th Feb. 1937	Mainly Ayrshire	80
	David Clark	Laigh and Mid Barnaigh, Kilbarchan	3rd April 1937	Ayrshire	58
	Matthew Y. Jamieson	Little Burntshields, Kilbarchan	28th April 1937	,,	33
	Orphan Homes of Scotland (per John Raeside)	Hattrick and Duchal Mains, Bridge of Weir	27th March 1937	,,	260
STIRLING	John B. Arneil	Ballewan, Blanefield	7th Feb. 1937	Mainly Ayrshire	45
	Wm. Betts Donaldson	Auchineden and Auchengillan, Blanefield	23rd Feb. 1937	Ayrshire and Galloway	90
	Robert Findlay	Cuilt, Blanefield	4th Feb. 1937	Ayrshire	53
	Mrs Catherine M. A. L. Fleming	Chapelarroch, Gartmore	22nd April 1937	,,	62
	James Miller	Westerton, Kippen	6th April 1937	Mainly Ayrshire	81
	Wm. Semple	Ballagan, Strathblane	8th Dec. 1936	Ayrshire	47
	James King Steel	Threaprig, Falkirk	19th Feb. 1937	,,	37
WEST LOTHIAN	Wm. Bryson	Parkhead, Linlithgow	12th Jan. 1937	,,	35
WIGTOWN	John H. Kay	Seaview, Port William	11th March 1937	,,	66
	David Kirkland	Mulloch, Newton-Stewart	7th March 1937	,,	57
	Alex., Robt. and John M'Caig	Kilhilt, Stranraer	19th Jan. 1937	,,	69

Unemployment in Agriculture

The following figures of unemployment in agriculture and allied industries have been supplied by the Ministry of Labour:—

INSURED AGRICULTURAL WORKERS,* AGED 14-64, RECORDED AS UNEMPLOYED AT 24TH MAY 1937.

INDUSTRY	MEN		BOYS		WOMEN		GIRLS		TOTAL
	21-64	18-20	16-17	14-15	21-64	18-20	16-17	14-15	
Farming, Forestry, etc.	1,913	216	206	81	239	36	41	25	2,757
Market Gardening, etc.	235	46	39	20	58	29	28	14	469
Other Gardening* ...	139	9	3	3	3	1	...	...	158
TOTAL* ...	2,287	271	248	104	300	66	69	39	3,384

* *Excluding Private Gardeners, who numbered* 35

The following table shows the numbers of wholly unemployed men and women, aged 18 years and over, registered at Employment Exchanges in Scotland at 1st March 1937, as applicants for work in agricultural occupations:—

	Men	Women	Total
Farm Worker . .	908	36	944
Farm Labourer . .	846	121	967
Poultryman . .	70	7	77
Fruit, etc., Picker .	330	145	475
Forester . . .	111	1	112
Forester's Labourer .	42	3	45
Gardener, etc. . .	528	18	546
Gardener's Labourer .	367	71	438
All Occupations . .	3,202	402	3,604

The following are the counties with the largest numbers:—Lanark, 721 (616 men, 105 women); Midlothian, 390 (321 men, 69 women); Aberdeen, 352 (347 men, 5 women); Angus, 284 (278 men, 6 women); Perth, 214 (194 men, 20 women); Ayr, 204 (170 men, 34 women).

Agricultural Conditions

THROUGHOUT the month of March very severe weather prevailed in most parts of the country; frost and heavy snowstorms were frequent and farm work was very considerably retarded. Towards the end of the month conditions improved somewhat and in some districts field work and cultivation were possible. During the first fortnight of April the weather was generally wet and cold, but the last two weeks of the month were in most districts drier and more genial. During the first half of May the weather was generally dry, with a good deal of sunshine, while in the second fortnight there was a considerable rainfall, with a fairly high temperature. Arrears of work on the land were overtaken and crops benefited from the favourable weather.

Owing to the severe weather conditions during March autumn-sown wheat generally lost its fresh, vigorous appearance; when the snow had cleared away plants were left colourless and weak. In April, however, the crop made a rapid recovery in some districts, and during May wheat generally made good progress. By the end of the month plants were vigorous, healthy and well advanced for the season of the year. In a number of districts, however, growth was rather irregular, some fields being patchy, thinly planted and backward. In Lower Moray some crops were damaged by grub, and in Stirling patchiness in most areas showed evidence of wire-worm. From a preliminary estimate it appears likely that the area under wheat this year will be about 100,000 acres.

The preparation of the land for spring sowing did not make normal progress, and at the beginning of April the sowing of barley had not begun in most districts. By the end of the month, however, it was generally well advanced or had already been completed. Germination of early-sown crops was fairly regular and the braird was generally looking well. Barley crops had a good appearance at the end of May, the young plants having maintained vigorous and healthy growth. Estimates of the area sown indicate that there will be a slight increase in the total for Scotland as compared with last year.

Progress in the sowing of oats was also very much behind that of a normal year; in most districts the work was not put in hand in March. By the end of April, however, sowing had been completed in many districts. Germination was generally good and the braird, where showing, was thick and healthy. Oats continued to make good progress during May and by the end of the month were generally in excellent condition. So far as can be ascertained from present estimates the total area under oats this season will show an increase of about 14,000 acres. Increases of about 10 per cent are reported from Kincardine, Lothians and Berwick and increases of 5 per cent in four other districts.

At the beginning of June beans were looking strong and healthy in all districts where grown and there were no complaints of injury by insects or weeds.

Owing to frost, snow and adverse weather conditions very little potato-planting had been done by the end of March. In a few districts some earlies had been put in, but in very few had the planting of late varieties been started, the soil not being in a suitable condition for cultivation. By the end of April in a few districts the work of planting the maincrop was about finished, but in most areas a good deal had yet to be done. Planting was carried out under ideal weather and soil conditions, and by the end of May was completed in every district. Early varieties were looking strong and healthy, while maincrops in some districts were already appearing through the ground. Estimates of the area planted indicate that the total acreage will be about the same as last year.

The sowing of turnips and swedes was well advanced in many districts by the end of May; swedes had almost all been sown, but in some cases yellow turnip sowing, although well forward, was not yet completed. In Berwick, Roxburgh and Selkirk sowing was considerably in arrear.

Sugar beet was showing through the ground in most areas and the braird had a vigorous and healthy appearance. In North-East Fife and the Lothians thinning had commenced. It is estimated that the total area under this crop will be slightly greater than that of last year.

Rye-grass and clover seeds made rapid progress during the latter half of April and, although backward as compared with an average year, the crop was generally vigorous and healthy. Abundant growth was made during May and prospects of good hay crops were very satisfactory.

Orchards were looking well and the fruit prospects were good. Blossom was very plentiful, particularly that of apples and plums, and conditions were good for the setting of both orchard and small fruit. In North and East Perth fruit trees presented the largest show of blossom for many years. In Kincardine and South-East Perth trees came to bloom very late.

Sheep stocks had to cope with very severe weather conditions during March; ewes in many districts became thin and low in condition, while severe snowstorms caused in some areas a very high death-rate among both sheep and lambs. By the end of April ewes were still in several areas weak and short of milk, with the result that lambs were in backward condition and smaller than usual. In Kintyre the lambing season was a poor one, many lambs dying through lack of milk among ewes. Lamb dysentery occurred in North, East and South-East Perth, while in Stirling there were some losses among lambs caused by wool-ball. The fall of lambs was generally about average.

At the beginning of May farm workers were scarce in Aberdeen, North-East Angus, Sutherland and Mid and East Lothian, while casual workers were difficult to obtain in South-West Angus, Roxburgh, Selkirk, Ross, Inverness, Nairn and Wigtown. In Renfrew, Ayr and Dumfries dairy workers were scarce; otherwise the supply of labour, both regular and casual, was ample for requirements. At the beginning of June the supply of labour was reported to be adequate in only eleven districts of the forty-four reported on. In North and East Perth ploughmen were short of requirements, many young men having left for industrial employment; in Mid Argyll workers were scarce owing to the demand for labour on road-making and other schemes. The usual scarcity of dairy workers was reported from Ayr, Dunbarton and Renfrew.

SCIENCE AND PRACTICE

The following extracts and summaries are mainly supplied by members of the staffs of Scottish agricultural colleges and scientific institutions. Full references to the original publications are generally given; if further information is desired regarding these, application may be made to the Secretary, Department of Agriculture for Scotland, 29 St. Andrew Square, Edinburgh 2.

CROPS AND SEEDS

Pea Mosaic. Its Symptoms, Economic Significance and Preventive Treatment. *E. E. Chamberlain. New Zealand Jour. of Agric., Vol. 54, No. 3.*—Pea mosaic is one of the most common virus diseases in New Zealand, and its incidence seems to be increasing. It occurs in the field on garden and field peas, blue lupins, red clover, broad beans, and sweet peas. Infected plants are stunted and usually paler in colour than uninfected plants. They flower later and produce flower pods which are smaller and less well filled than those of healthy plants, and mature more slowly. The aphides *Myzus persicæ*, *Aphis rumicis* and *Macrosyphum gei* are vectors. The disease over-winters in red-clover plants and is spread to other susceptible hosts by migrating aphids. The garden-pea varieties Lord Chancellor and Little Marvel are immune. Suggested methods of control are:—(*a*) use of immune pea varieties, and (*b*) the planting of susceptible annuals far removed from areas of infected red clover.

The Cleaning and Handling of Barley. *J. G. Malloch. Sci. Agric., Vol. XVI, No. 6, Feb.* 1936.—The machines now available for cleaning barley have a reasonably high degree of efficiency. The peeling or skinning of malting barley is a very serious problem because it affects the quality of that portion of the barley crop which brings the best price, and for which there is a steady though not unlimited market. The results of the investigation made by the author show that a large proportion of the damage is attributable either directly or indirectly to bad threshing. Damage can be reduced by observing certain simple precautions:—(1) the use of a minimum number of concave teeth, (2) adjusting the chaffer and sieves so as to produce a minimum of grain for re-threshing, (3) keeping the cylinder speed as low as possible, (4) prevention of end play in the cylinder, (5) threshing on cool and cloudy days.

The fact that varieties differ in their susceptibility to damage makes possible the permanent solution of the problem by the breeding of varieties that are resistant to damage. This character could be used as one of the bases of selection by every plant-breeder working with malting barley.

Actual Problems of Potato Breeding. *Professor H. M. Quanjer. Report of the International Congress of Plant Breeders, 22-27th June* 1936. *Leiden, E. J. Brill,* 1936.—A great number of varieties of potato exists; too many varieties and too many names also are troublesome. In Germany the Committee for Synonymity reduced the number from many hundreds to 250 in 1925; the number was reduced to 66 in 1935.

Deterioration of potatoes was regarded as a consequence of vegetative propagation and new varieties were raised from seed. In Holland it was found that degeneration (" running-out ") did not exist, the deterioration was due to virus diseases. Many potato plants raised from seed are free from virus. Selection of virus-free plants, early lifting, propagation in a rigorous climate keep varieties in a good state of health. Production has been increased more by selection within the variety than by the selection of new varieties. Consequently it is more difficult nowadays to get better varieties from seed than it was before.

Many breeders have done haphazard work. One of the main objects in potato breeding is to obtain homozygous types by inbreeding and to combine desired properties by synthesis. This must in future lead to better results and to a better knowledge of hereditary factors or genes.

Only a restricted number of varieties of *S. tuberosum* has been introduced in productive centres in Europe, and the number of hereditary factors or genes was consequently restricted. Interest in the great number of Solanum species existing in South America and Mexico is growing. Resistance to late blight has been detected in *S. demissum* and in *S. andigenum.* Resistance to virus seem to exist in *S. Rybinii.*

It is difficult to raise varieties really resistant to virus disease: no variety is resistant to leaf-roll which is only one of the many virus diseases.

The Problem of Causes of Blackening in Cooked Potatoes. *W. E. Tottingham, Rudolph Nagy and A. Frank Ross. Amer. Potato Jour., Vol. XIII, No.* 11, 1936.—(From authors' summary).—The blackening of cooked potatoes does not appear to be associated with transmissible pathological conditions.

This abnormality appears to be associated to a limited extent with higher percentages of nitrogen in the dry-matter of the tuber.

In comparison with normal potatoes, those which blacken after cooking contain in the raw state, relatively high proportions of free amino acids. This relation applies particularly to tyrosine, which fails to show the normal increase on boiling the abnormal tubers.

Immaturity of the plant is not a primary factor in the blackening of tubers after cooking.

Storage at high temperature and with greatly curtailed ventilation does not induce the blackening response significantly.

When the soil content of available K_2O (Potash) was less than 200 lb. to the acre, potatoes of several varieties blackened after cooking, but this response was negligible when the supply approached 400 lb. Samples containing large proportions of blackening tubers contained an average of less than 1·8 per cent K_2O in the dry matter, whereas the average content was above this level in normal tubers.

ANIMAL BREEDING

A Study of Certain Breeding Practices in Pig Production. *A. M. Shaw and J. W. G. MacEwan.* 1936. *Scient. Agric., 16*: 322-330.—The importance of the crossbred for commercial meat production has been recognized by practical stocksmen throughout the world. The authors of this paper draw attention to the fact that Smithfield Market, the most discriminating in the world, indicates that the finest meat products are frequently the result of crossbreeding. This paper deals with experiments to determine whether similar methods might be used for Canadian bacon production. The main experiments were preceded by two reports of double-mated litters, where the sow has produced a mixed litter, some sired by a boar of her own breed, and others by a boar of another breed. These indicated an advantage for the crossbred, but the figures were too scanty to allow of definite conclusions being drawn.

Accordingly, the main experiment was started in the summer of 1929, when 20 gilts, consisting of 4 Tamworths, 4 Yorkshires (Large Whites), 4 Poland-Chinas, 4 Berkshires, and 4 Duroc-Jerseys, were selected at the University of Saskatchewan. The breeding programme covered a five-year period, using a boar of different breed each year, so that all the possible crosses were made, and each year's crop of pigs consisted of one group of purebreds and four groups of crossbreds. The boars used were of the same breeds as the sows.

Records were kept of birth and weaning weights, and the experimental feeding period began one to two weeks after weaning. Feeding and management were as nearly uniform as possible. The feeds consisted of wheat offals, barley, buttermilk, salt, and minerals, with freshly-cut alfalfa (Lucerne), and with access to outside runs.

No evidence was obtained that the crossbred pigs were capable of quicker fœtal development or had shorter gestations. There was no significant difference in the birth weights of crossbred and purebred pigs.

Canadian farmers believe the Tamworth to be the best mother. Evidence of weaning weights substantiates this theory. The Tamworth sows brought the heaviest pigs to weaning age, and were noticeably superior to the Yorkshire sows, which were the poorest in this respect. As regards the weaning weights of the purebred and crossbred pigs, the latter beat the purebreds in all but one instance, where the purebred Tamworths were heavier than the crossbred Tamworths at weaning, a fact not inconsistent with the former observation that Tamworth sows have demonstrated relatively heavy milking tendencies. The greater weaning weight of the purebred Tamworths might therefore be attributed to the improved nourishment provided by their dams. The average weaning weight for all purebreds was 35·7 lb., and for all crossbreds 39·38 lb. As the difference at birth was insignificant, the conclusion is drawn that the crossbred pigs possessed increased vigour and rapidity of growth in the suckling period.

As regards feeding qualities, the crossbreds had a higher average daily gain of 1·24 lb., as compared to 1·15 lb. for the purebreds. An examination of the figures shows that when purebred pigs of any single breed are compared with the crossbreds of which the same breed is a parent, in three out of five times the crossbreds outgain the purebreds in a significant manner: in the two remaining instances the average daily gains were the same for both the purebreds and the crossbreds.

As regards economy of live-weight gain, the crossbreds again had the advantage with a consumption of 3·45 lb. of grain as against the purebreds' 3·53 lb. of grain per pound live weight. Here again the purebred Tamworths beat the Tamworth crosses, and in the case of the purebred and crossbred Duroc-Jerseys, there was no difference. Allowing for the consumption of buttermilk, it was calculated that the crossbreds consumed 4·29 lb. of grain equivalent per pound live weight gain as against the purebreds' 4·40 lb. These differences are not great, and no one breed or cross demonstrated marked superiority. But the more rapid and economical gains made by the crossbred pigs over the whole period indicate the advantage of crossbreeding.

A complete record of market grades was secured. From this it was quite evident that the Yorkshire and the Tamworth breeds rank high in comparison with the Berkshire, Duroc-Jersey, and Poland-China, the last two of which are definitely unsuited for Canadian and British market requirements. The Yorkshire boar was the most effective in correcting faulty bacon type characteristics.

The writers conclude that there is a correlation between rate and economy of gain. In this experiment the crossbred pigs utilize their feed more efficiently than the purebreds. They are, however, chary of drawing definite conclusions on this point, and emphasize the fact that type within the breed is of prime importance to the producer of bacon pigs because of the fact that profit hinges largely on the market grades. In view of certain difficulties they do not advocate the practice of crossbreeding in Canada, except for those breeders who are in a position to maintain the purebred herd as well.

There is a short note on colour, which confirms that the white of the Yorkshire behaved as dominant in the crosses with the other breeds. The black of the Poland-China and Berkshires appeared to be incompletely dominant to red, and the F[1] of these breeds with the Duroc-Jersery and Tamworth resulted in spotted pigs with black predominating. The reciprocal crosses were all the same as regards colour.

Some Observations on Carcase Quality in the Bacon Hog. *R. D. Sinclair and J. Allan Murray.* 1935. *Scient. Agric.*, *16*: 169-174.--This paper deals with various aspects of the quality of the carcases from bacon pigs. Five litters, two of which were purebred Tamworths, and the remainder Yorkshires (Large White) were raised under similar environmental conditions, and their carcases examined. The difference in average length was not noticeable, but a definite relation was obtained between the weight of the ham and shoulder, and this was uniform as between litters. Depth of back fat and thickness of belly varied considerably. Litter trends were in evidence in that certain litters showed a thick belly, while others lacked this. One litter was particularly good, having low back fat and high belly measurements. This litter also showed the highest percentage of lean.

In another series of measurements the authors were able to obtain a definite correlation between certain body and carcase characteristics based on 350 carcases.

Carcases were divided into shoulder, middle, and ham. The authors conclude that the ideal condition is 25% shoulder, 50% middle, and 25% ham. The average for the 350 carcases was 28·5% shoulder, 47·5% middle, and 24% ham.

On another series, on 106 carcase measurements, a positive correlation of +·88 was obtained between the percentage of lean meat and the percentage of ham. As the ham tended to increase in size in proportion to shoulder and middle, the proportion of lean meat in the side increased. No consistent relationship was obtained between back fat measurements and percentage of lean. Correlations were calculated between percentage " eye of lean " and carcase measurements. A high positive correlation (+·95) was found between the percentage " eye of lean " and the percentage of ham. In other words, the better the ham, the larger the " eye of lean," and there was more extensive muscling in the cross sections which were studied.

In conclusion, the authors state that the importance of feeding and management practices in relation to the quality of the finished article must not be overlooked, but when consideration is given to the variability which occurs among closely related pigs similarly managed, the importance of the breeding aspect becomes clearly manifest.

A New Lethal Factor in the Horse. *R. Prawochenski.* 1936. *J. Heredity*: *27*: 410-414.—Nearly half the foals of an Anglo-Arab stallion used in a Polish stud were born with deformed forelegs, with typical crooked immobilized phalangia. The hind legs were quite normal, as was the general conformation and development of the foals.

The data put forward by the author definitely show a genetic basis, but it is obvious that it cannot be a simple recessive, and in view of the fact that steps have naturally been taken to cease from using the stallion, it is unlikely that further information will be available.

The case is noteworthy in that it reports what is probably one of the few cases of lethal, as distinct from the many sub-lethal genes in the horse.

The Lethal Nature of Flightlessness in the Fowl. *D. C. Warren.* 1937. *J. Heredity*: *28*: 17-18.—" Flightless " is a heritable defect in the fowl which causes abnormal feathers, particularly the larger ones, and this results in the flight feathers breaking off near the base when subject to strain. The author points out that this is an heterozygous condition, and that the homozygote is practically lethal, showing non-development of the feathers and deformed beaks and toes. It would appear that not all the homozygotes are born alive.

ANIMAL NUTRITION

Fresh Milk Waste as a Fodder. *R. Fangauf. Wiss. Ber. 6. Weltgeflügelkongr. Berlin and Leipzig,* 1936, *Vol.* 1, *256-257. English Summary, Vol.* 3, *p.* 32. (*Kiel-Steenbek, Germany*).—Feeding hens with surplus milk products saved fodder, had a favourable effect on setting and raising of broods, caused increased gains in weight and improved the quality of the flesh. Hens will consume on an average 250 g. skimmed milk per day when water is not available; but 115 g. is all that is required to produce the best laying results.

Notes on Locust Meal as a Poultry Feed. *F. M. Fronda. Philippine Agric.*, 1935, *24*, 425-427.—A preliminary test using two lots of three chicks each was conducted at the College of Agriculture. The results of the chemical analysis indicated that locut meal could be profitably used as a source of protein for chicks. If used to supply the optimum level of protein it may increase the crude fibre content of the ration beyond a desirable point. Locust meal was not as efficient but was as palatable as fish meal.

Comparison of Management Methods for Chicks, Layers and Breeding Hens.—*C. W. Upp. Louisiana Agric. Exp. Stat. Bull. No. 275, Sept.* 1936, *pp.* 14.—Apparently owing to the prevalence of coccidiosis, chicks reared on litter and allowed access to runs from an early age grew more slowly than those confined till mature on wire. There was also a higher mortality, but this was reduced somewhat by hatching early. In the laying houses, however, as a result of cannibalism, mortality was usually higher in the confined lot than in those getting outside. Egg production and hatchability were lower, while food consumption per dozen eggs was higher. Details of the rations used are not given.

Use of Whey in Pig Breeding. *A. Kube. Ztschr. Schweinezucht,* 1936, *43*, 727-729. (*Nochen*).—Satisfactory results are reported for pastured sows fed whey to appetite, approximately 20 litres daily per sow being consumed in winter and up to 40 litres in summer. In winter the cows received beet in addition. Protein concentrates were given 14 days before farrowing and in increased amounts during suckling. The sows had a good milk supply and the piglings throve. Digestive disturbances never occurred in the piglings and were of rare occurrence, and at once cured by wood charcoal in the sows. Piglings can be given small quantities of whey at 10-12 weeks old and unlimited quantities at 14-15 weeks. The danger of giving whey to piglings is emphasised, but it is suggested that fresh whey (the whey used was sour) might have no harmful effects.

Protein Requirements of Fat Pigs. *Wo. Ztschr. Schweinezucht,* 1936, *43*, 695-697.—The literature on the subject is briefly reviewed. It is concluded that the Lehmann standards give excellent results, but they are higher than those of some other investigators, and it is possible, particularly with older pigs, to reduce the protein to some extent. The Lehmann standards are as follows:—

Mean Pig Weight kg.	Protein Requirement g.	Starch Equivalent Requirement g.
29	210	970
44	290	1,400
62	340	1,830
83	360	2,180
103	370	2,290

The Effect of Feeds on the Quality and Palatability of Lamb. *J. E. Richardson and W. F. Dickson. Montana State Coll. Agric. Exp. Stat. Bull. No.* 320, *May* 1936, *pp.* 19. (*Bozemann, Montana*).—The effect was determined of different concentrates and of weed seeds on quality and palatability of fat lambs. The cooked flesh from lambs was judged according to an arbitrary system of points. The results showed the great danger of undesirable taint when hard weed seeds of various species, particularly fanweed, were fed. Wild turnip seed also produced taint. A mixture of weed seeds gave a more unpleasant taint than the seeds of individual weeds fed separately. The taint was still detectable 60 days after the source of taint was removed. Some weed seeds, *e.g.*, tumbling mustard seed, gave flesh of desirable quality and flavour.

Among the more commonly used concentrates, oats were found to be superior to barley, and barley to wheat.

Value of the Mallow as Fodder. *W. Wöhlbier, W. Schramm and G. Herold. Landwirtsch. Jahrb.*, 1936, *83*, 555-584. (*Agric. Exp. Stat., Rostock*).—Figures are given showing the composition of 2 varieties, smooth and curly leafed, of the fodder mallow, *Malva verticillata*, at different stages of growth. Digestibility trials with sheep carried out on the material made into hay or on the straw, either coarsely chopped or finely pounded, showed that neither had a very high feeding value. There was a marked loss of nutritive value during the process of hay making owing to the slow rate of drying. The green fodder or artificially dried hay had a higher nutritive value. The green fodder made satisfactory silage which, however, was not eaten by animals.

Damaged Potato Silage. *V. Bismarck. Ztschr. Schweinezucht*, 1936, *43*, 697-698. —The correct procedure for ensiling potatoes in earth pits is outlined. The pit should be so constructed that its walls are impermeable to water. It should be covered with clay. The potatoes should be thoroughly washed and closely packed to exclude air. The silo should be rapidly filled so that the potatoes do not have time to cool. The steaming of the potatoes should be adequate but not excessive.

DAIRYING

Tested Sires and Dams of the Jersey Breed. *Amer. Jersey Cattle Club.* 1936.— This book is interesting as revealing the method by which Jersey breeders in the United State are enabled to discover superior germplasm within the breed. It is divided into three sections, tested sires, tested dams, and the classification ratings of sires and dams. All records are age-corrected, and also to 365-day equivalents.

Each tested sire is listed alphabetically, with the names of his sire and dam, and the total number of his registered daughters that that have reached the age of four years. The number of his tested daughters is also given with their average production expressed, firstly, in pounds fat, then pounds milk, then percentage butterfat. Details are also given of the number of daughters making their records on twice, thrice, and four times milking daily. The date of birth of the bull, and the name of his owner are added. Included in this section is a list of superior sires, at least fifty per cent of whose daughters have been recorded in the Register of Merit with a yield exceeding 600 pounds butterfat. There is also a list of tested sires whose daughters averaged over 600 pounds butterfat.

In the second section, dealing with dams, it is laid down that any registered cow may be entered when at least three of her daughters have completed production records. In place of the daughters tested sires are accepted. There is also a list of tested dams whose progeny averaged over 700 pounds butterfat.

The final section deals with the type classifications of the daughters of various sires, including animals which have been re-classified. These daughters are classified in ratings as follows, in order or merit:—excellent, very good, good+, good, fair, and poor. And to these ratings scores are assigned. For a sire to be awarded the title of " superior sire " the scores for all daughters so classified must average " good+."

This book, which is supplementary to a previous volume, deserves to be studied by all concerned in the administration of dairy breed societies.

Variations in the Vitamin C Content of Milk. *C. H. Whitnah and W. H. Riddell.* 1937. *J. Dairy Sci.*, *20*: 9-14.—Forty cows about equally distributed among Ayrshire, Guernsey, Holstein, and Jersey breeds were tested for three consecutive mornings in October, and again in November. Sixteen of these cows were also tested both morning and evening for seven days. Subsequent tests included all the cows of the station herd whose rations were all similar, consisting of alfalfa hay, sorgo silage, and a grain mixture, with no pasture available.

A few cows were also fed in April. The Jerseys proved to be the highest in Vitamin C content, and there is no doubt but that the higher values for these Jerseys in this herd are significant. Of these eight, six were genetically related, and, while the numbers are too small to allow of a definite conclusion, it does appear as though individuality and breed of the cow affected the Vitamin C content.

The next most important factor affecting it is the stage of lactation.

Biennial Review of the Genetics of Dairy Cattle. *A. D. Buchanan Smith.* 1937. *J. Dairy Res.*, *8*: 131-42.—This covers the work which has been published during the past two years, and deals with measures of inheritance of total yield and its relation to fat production. There are also sections dealing with butterfat and other constituents of the milk, the relation of conformation to production, the efficiency of production, methods of improvement, and tropical dairy cattle.

Size as a Factor in Performance. *E. Feige. Milchwirtsch. Forsch.*, 1936, *18*, 769-175. (*Liegnitz*).—In the examination of data from 1,300-2,000 cows no correlation could be found between size, productive output and efficiency of food utilisation. Body form cannot therefore be taken as a guide to productive efficiency. In cases where correlations have been found between liveweight and milk production, as in American observations on Guernseys, age must be taken into account.

An Experiment in Chopping Alfalfa Hay at the Time of Storage. Effect upon Space required, Temperatures attained, Colour, Feeding Value, and Losses of Feed Constituents. *T. E. Woodward and J. B. Shepherd. J. Dairy Sci.*, 1936, *19*, 697-706. (*Bur. Dairy Indust., U.S. Dept. Agric., Washington*).—More hay could be stored with less labour in a given space after being chopped, but the hay heated more readily the finer it was chopped. Chopping resulted in a loss of carotene content and green colour. Cows milked slightly better on long hay. The hay used in this experiment contained 25-27 per cent moisture.

Alfalfa-molasses Silage vs. Alfalfa Hay as a Roughage for Lactating Dairy Cows. *R. E. Horwood and J. G. Wells (Jr.). Quart. Bull. Mich. Agric. Exp. Stat.*, 1936, *19*, 100-104. (*East Lansing, Michigan*).—Two groups of 3 cows were maintained for three 30-day periods on the double reversal method of feeding. On alfalfa-molasses silage the cows consumed more digestible protein and less total digestible nutrients and produced more milk (4 per cent fat standard) than on alfalfa hay. They gained 46 lb. more weight on the hay than on the silage. Alfalfa did not maintain its carotene content when ensiled with molasses.

Homogenisation as a Preventive of Oxidised Flavour (in Milk). *Ross* (1937) *Milk Plant Monthly*, *26* (4/5) 36, 40.—The author shows that the so-called oxidised (metallic, cappy) flavour which frequently causes trouble in market milk may be prevented by effective homogenisation (1,500 lb. per sq. in.) of the milk after pasteurisation. Milk so treated will not develop the oxidised flavour even when copper is added to the after homogenisation. The hypothesis is advanced that the prevention of the oxidised flavour in milk by homogenisation may possibly be due to the formation of a film round the fat globules. It should be noted that it is only homogenised milk which behaves in this way, and that raw milk which is homogenised becomes bitter or rancid shortly after treatment.

Improving the Flavour of Market Milk by Clarification. *Jorgensen* (1936) *Mælkeritidene 49*, (32), 646.—The flavour of market milk is sometimes adversely affected by the foods fed to the cows; turnips and turnip tops injudiciously employed are especially implicated, producing a strong disagreeable odour and taste in the milk. Earlier attempts in Germany to improve the odour and flavour of such milk by treatment in specially constructed vacuum containers were not very successful, and the best that could be done in those difficult periods when this flavour defect was prevalent was to pass the milk over the rippled surfaces of the open type of heaters and refrigerating coolers. The popularity in recent years of the closed heater and cooler has drawn attention anew to means of dispersing food flavours in milk. At the Experiment Station at Kiel, Dr Eichstädt has shown the beneficial effects of centrifugal clarification: from a bacteriological standpoint, he finds that clarification at relatively high temperatures (140°-150° F.) is as good as at lower temperatures (68°-104° F.). At high temperatures, part of the sediment passes into solution, but on the other hand, one obtains a more effective deodorisation of the milk.

SOILS

A Short Review of Experimental Work on the Manurial Value of Synthetic Urea. *K. J. Sinclair. Empire Jour. Exper. Agr.*, 5, 18, 1937. *pp.* 162-168.—Information obtained from trials with urea in Britain, United States, Australia and elsewhere is summarized. Evidence is presented that, on crops of temperate regions, urea is comparable in effectiveness with sulphate of ammonia and chloride of ammonia; on crops in tropical regions there is little evidence, but on sugarcane in Java and Natal it appeared less effective than sulphate of ammonia.

The Phosphate Status of Mauritius Soils. *N. Craig. Empire Jour. Exper. Agr.*, 5, 17, 1937. *pp.* 11-18.—Almost all the Mauritius soils are liable to suffer from a deficiency of available phosphoric acid. Recognition of soil type is not sufficient to indicate whether phosphate manures are necessary, so that soils have to be considered individually. The highly laterized soils do not appear to contain any appreciable amount of calcium phosphate, the main supply being associated with the sesquioxides. In the more nearly neutral soils there is evidence that basic iron phosphate supplies a certain amount of available phosphate, and at the same time it seems probable that there is also a certain amount of calcium phosphate. All the lateritic soils possess a high fixation power, but the grey soils of the dry districts, which cannot be considered lateritic soils, have totally different properties, and their retentive power is low.

The Response of Grasses and Clover to Treatment on Acid Upland Soils, and the Effect of Herbage Plants on the Reaction of Acidic Soils, Part 3. *R. O. Davies and W. E. J. Milton. A comparison of the produce of Molinia and Fescue Soils.* 5, 17, 1937. *pp.* 48-62.—A comparison is made of the response of Molinia and Fescue soils from an area in Wales to different treatments over a period of 5 years (1931-5). The outstanding feature of the results is a marked increase in yield, coupled with a much higher concentration of nutrients in the herbage of the treated plots from both soils. A higher yield of natural herbage was obtained as a result of manuring and cultivation from the Fescue soil than from the Molinia soil. The effects of applications of basic slag and limestone singly or combined, both on the yields and concentration of nutrients, are described.

The Effectiveness of Cultural Treatments in the Control of Weeds. *B. N. Singh, K. Das and G. V. Chalam. Empire Jour. Exper. Agr.*, 5, 17, 1937. *pp.* 63-68.—The experiments indicate that increased seed-rate has a definite effect on weed control in fields infested with *Chenopodium album*, and that farmyard manure increases the weed density. The results show that weed control is influenced by cultural treatment.

First Report of the Plant Food Advisory Council of New South Wales, Australia. *Bull.* 1. *Sydney*, 1933. *Superphosphate*, 10, 1937. *pp.* 13-15.—The Report gives a resumé of experiments on the manurial treatment of pastures and other crops conducted in 1932. Excellent results were obtained with superphosphate in all the experiments, giving, in the case of pastures, the highest net profit. Along with superphosphate, nitrogen and potash further increased the surplus yield in grass and clover. At the close of the grazing period pastures recovered within the shortest time when treated with complete fertilizers consisting of nitrogen, phosphate and potash. In conjunction with the other commercial fertilizers lime had a particularly beneficial action on pastures along the coastal region. Liming itself showed less favourable results. Cattle showed a decided preference for the pasture on the fertilized plots, and excelled in regard to milk yield and general health.

Effect of Calcium Cyanamide on the Soil Microflora with Special Reference to Certain Plant Parasites. *C. M. Hænseler and T. R. Moyer. Soil Science* 43, 2, 1937.

—The effect of calcium cyanamide on the soil microflora seemed to be more closely correlated with the soil reaction than with the quantity of material used.

Both calcium cyanamide and hydrated lime proved effective in controlling club-root of crucifers caused by *Plasmodiophora brassicæ*. In field tests a combined treatment of calcium cyanamide and hydrated lime gave better club-root control than did calcium cyanamide alone and gave higher yields than did lime alone.

In a pot test, calcium cyanamide gave no control of beet-scab caused by Actinomyces scabies.

Formamide and Ammonium Formate as Nitrogen Sources for Plants. *B. E. Brown and F. R. Reid. Soil Science* 43, 5, 1937.—The results of pot tests show that formamide and ammonium formate compare favourably with two standard nitrogen sources, ammonium sulphate and urea.

Formamide as a Nitrogenous Fertilizer. *Rehling and Taylor. Journ. Amer. Soc. Agron.* 29, 2, 1937.—An account is given of experiments designed to test the value of formamide as a source of nitrogen. This substance, which decomposes in the soil in the course of a few days, is shown to be a useful nitrogenous fertilizer.

Increasing Amounts of Potassium as 40% Potash Fertilizer and as Cement Potash. A Nine Years' Experiment on recently Cultivated Sphagnum Peat Soil at Flahult (Sweden). *G. Rappe. Svenska Mosskultur Tidskrift* 51, 1, 1937.—Dressings of 35, 70 and 140 lbs. K_2O per acre gave mean increase in yield of 50%, 80% and 120% over the whole period. They were largest for the two years following the application, when increases of up to 300% were obtained in a hay crop. Red clover and timothy covering increased as a result of potash. Increased yields were also observed for barley, peas, potatoes and oats. The effect of cement potash appeared to be more permanent than that of potash salts.

Comparison between the Effects of Different Nitrogenous Fertilizers in Grassland Experiments at Gisselas and Sörbyn. *G. Rappe. Svenska Mosskultur Tidskrift* 51, 2, 1937.—Both sets of experiments were carried out on sedge bog soils. With small applications of nitrogen it appeared immaterial whether it were applied as nitrate or ammonia. With larger applications fertilizers containing nitrogen as nitrate were most effective at Sörbyn (more temperate climate and little lime in the soil), whilst those containing ammoniacal nitrogen were more effective at Gisselas (more continental climate with much lime in the soil). Cyanamide gave the smallest yield in both experiments, especially so at Gisselas. Clover and weeds were more abundant in the untreated plots than the treated. Timothy better in the plots receiving sulphate of nitrogen, niturate of lime and cyanamide plots.

On the Effect of Potash Fertilizers in Increasing Potato Yields, with Special Reference to Soil Reaction. *Nemec. Die Ernährung der Pflanze* 33, 10, 1937.—It is found that high soil acidity lessens the response of the potato crop to potash manuring.

On the Influence of Potash Deficiency on the Development of the Sugar Beet. *Wimmer. Die Ernährung der Pflanze* 33, 3, 1937.—Except in cases of extreme deficiency actual leaf production is not greatly affected by potash shortage. A corrugated appearance of the surface of the leaf and a brittleness of the stems are generally the first indications of potash deficiency. Later the plants show irregular growth and in the older leaves light green spots develop and these gradually turn brown. Younger leaves become narrow and pointed and develop oval brown spots along the stems.

Availability of Phosphate Rocks in Soils of Varying Degrees of Acidity. *Bartholomew. Journ. Amer. Soc. Agron.* 29, 4, 1937.—Although there is some tendency for the availability of the phosphate to increase with an increase of acidity, there appears to be no close relationship between soil acidity and availability of the phosphorus in phosphate rocks. The phosphate availability is shown to be closely associated with the fluorine content of the rock; generally, regardless of acidity, the availability decreases as the fluorine content increases.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS AND FERTILISERS IN MARCH, APRIL and MAY 1937

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	MARCH			APRIL			MAY		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen Angus ...	44 5	40 5	38 9	47 0	43 1	40 1	48 9	44 7	41 6
Cross-bred (Shorthorn)	41 6	38 3	30 7	44 3	40 10	32 11	46 7	42 11	34 4
Galloway	42 3	37 9	...	45 8	40 6	..	50 3	44 4	...
Ayrshire	41 2	35 7	...	44 6	39 6	31 6	47 3	42 9	32 6
Blue Grey	43 9	40 7	39 2	46 1	42 4	40 6	49 2	45 1	41 6
Highland	..	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	14½	7¼	..	13	7¾	...	13½	8	...
	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd per lb d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd per lb. d.	Ewes per lb. d.	Hoggs under 60 lb. per lb. d.	60 lb. and upw'd per lb. d.	Ewes per lb. d.
†SHEEP—									
Cheviot	13	11¾	9	14	12¾	9¼	14¼	13	9¼
Half-bred	12½	11	8	13½	12½	8	13½	12½	8
Blackface	12¾	11¼	8¾	13¾	13	9½	14	12¾	9¼
Greyface	12¾	11¼	7¾	13¾	12¾	8¼	14	13	8½
Down Cross	12¼	11¼	8¼	13½	12½	8½	13¾	12¾	8¾
†PIGS—	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.	per stone s. d.
Bacon Pigs	10 0	9 2	...	9 9	9 0	...	9 8	8 10	...
Porkers	10 9	9 9	...	10 5	9 6	...	10 2	9 4	...

* Live weight. † Estimated dressed carcase weight.

Live Stock: Monthly Averages of Prices (per head) at certain representative Scottish Markets—(*continued*).

Description	March			April			May		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
Cattle—									
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	15 3	11 17	10 10	16 6	13 1	12 0	17 2	14 0	11 13
Two-year-olds ...	19 1	15 12	...	20 7	16 15	14 10	22 8	18 4	14 9
Cross-bred (Shorthorn)									
Yearlings	14 0	11 9	10 15	14 17	12 10	11 12	15 13	12 12	11 13
Two-year-olds ...	18 9	15 7	14 6	19 12	15 19	14 15	19 18	16 9	14 12
Galloway:									
Yearlings	12 12	10 8	...	14 15	11 10	..	15 19	12 0	...
Two-year-olds ...	...	...	...	21 13	15 15	...	20 9	16 6	...
Ayrshire:									
Yearlings	...	...	...	11 6	...	...	13 13	10 15	..
Two-year-olds ...	.	..	...	14 18	...	...	15 14	14 0	...
Blue Grey:									
Yearlings	...	...	...	...	...	...	15 3	12 15	...
Two-year-olds ...	...	...	...	...	...	...	17 10	15 10	...
Highland:									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Three-year-olds ...	...	...	...	...	...	...	15 0	...	...
Dairy Cows—									
Ayrshire:									
In Milk	26 3	20 6	15 6	27 4	20 2	14 11	27 4	20 4	15 18
Calvers	26 19	20 10	15 9	27 13	21 2	15 15	27 10	20 18	16 7
Shorthorn Cross:									
In Milk	26 5	19 3	16 9	26 12	19 0	17 4	26 10	19 4	17 5
Calvers	25 12	17 14	15 16	25 14	18 4	16 18	27 0	19 1	16 12
Sheep—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Cheviot Hoggs ...	48 2	33 0	...	52 5	39 0	...	...	...	...
Half-bred Hoggs ...	58 4	50 1	39 7	64 9	52 8	42 3	64 5	53 10	...
Blackface Hoggs ...	29 11	22 2	..	35 11	28 1	...	41 1	31 1	...
Greyface Hoggs ...	49 1	38 8	32 7	56 5	46 3	41 6	53 5	45 1	...
Down Cross Hoggs	50 0	42 5	...	61 9	54 4	...	59 8	51 4	...
Pigs—									
(6 to 10 weeks old)	35 3	24 3	...	35 0	24 2	...	34 2	23 5	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	MARCH			APRIL			MAY		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
BEEF :—		per lb.	per lb.	per lb.	per lb.	per lb.	per lb.	per lb.	per lb.	per lb.
Home-fed—		*d.*	*d.*	*d.*	*d.*	*d.*	*d*	*d.*	*d.*	*d.*
Bullock or Heifer ...	1	6⅞	6⅝	8	7⅜	7½	8¼	8¼	8⅛	9
	2	6⅜	...	7⅜	7⅛	...	7¾	7⅞	...	8⅜
Bull	1	5⅞	5¼	5¼	6⅜	5⅜	5½	6¾	6	5¾
	2	5¼	...	4¼	5⅞	...	4½	6⅜	..	4⅞
Cow	1	5¼	5	5¼	5¾	5⅛	5½	6½	5⅝	5¾
	2	4¼	...	4¼	5	...	4½	6	...	4⅞
Irish—										
Bullock or Heifer ...	1	...	...	7¼	...	...	7⅝	...	...	7⅞
	2	...	...	6¼	...	...	6⅞	...	..	7⅝
Argentine Frozen—										
Hind Quarters ...	1	...	5	...	...	4⅞	. .	...	5⅛	...
	2	...	4⅝	...	...	4½	...	...	4⅝	...
Fore ,, ..	1	...	4⅛	...	...	4½	...	.	4⅞	...
	2	...	3¾	...	...	4⅛	...	...	4⅜	...
Argentine Chilled—										
Hind Quarters ...	1	6	6⅜	6¼	6¼	6½	6⅛	7	6⅞	6¼
	2	...	5⅞	5½	...	6	5½	...	6⅛	...
Fore ,, . .	1	4⅛	4¼	4⅜	4½	4⅞	4⅝	5⅛	5⅜	5¼
	2	...	4	4	...	4½	...	...	4⅞	...
Australian Frozen—										
Hind Quarters ...	1	4½	..	4⅜	4½	...	4½	4⅞	...	4½
Crops	1	3¾	...	3⅝	4⅜	...	4	4¾	...	4½
New Zealand Frozen—										
Hind Quarters ...	1	4½	...	4⅜	4½	...	4½	4⅞	..	4½
Fore ,, ...	1	3¾	...	3½	4¼	..	4	4⅞	...	4
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	11¾	11⅜	11¾	12¾	12⅝	12⅝	13½	13¼	13¼
	60 lb. & over	10⅞	...	11	12	...	11⅝	12½	...	12¼
,, Cross ...	under 60 lb.	11¾	11⅜	11¾	12¾	12⅝	12⅝	13½	13¼	13¼
	60 lb. & over	10⅞	...	11	12	..	11⅝	12½	...	12¼
Ewes, Cheviot ...	1	...	8⅛	8⅝	...	8⅛	9½	...	7⅞	9½
	2	...	...	8¼	...	...	9¼	...	...	9¼
,, Blackface ...	1	8¼	8⅛	8⅝	9¾	8⅛	9½	9½	7⅞	9½
	2	7¾	...	8¼	8¾	...	9¼	8¾	...	9¼
,, Cross	1	6⅝	8⅛	7¼	7¾	8⅛	7¾	8½	7⅞	8
	2	5⅝	...	6⅝	6¾	. .	7¼	7½	...	7½
Argentine Frozen ...	1	...	...	4¼	...	...	4½	...	...	4⅝
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	5½	4½	...	5¼	4¾	...	5⅛	4¾
	2	...	4½	...	...	4½	...	...	4⅝	...
New Zealand ,, ...	1	...	...	4⅞	...	...	5	...	...	5⅛
	2	...	...	4½	...	...	4¾	...	...	4¾
LAMB :—										
Home-fed	1	16	..	12⅝	18	...	15⅝	18	..	15⅞
	2	...	...	11⅞	...	...	12¾	17	...	13¼
New Zealand Frozen	1	...	7⅞	7	...	7¾	7¼	...	7⅝	7¼
	2	...	7	. .	...	6½	...	...	6⅜	...
Australian ,, ...	1	...	...	6¾	...	...	6¼	...	...	6¼
Argentine ,, ...	1	...	...	6¾	...	...	6½	..	...	6½
		per cwt.	*per cwt.*	*per cwt.*	*per cwt.*	*per cwt.*	*per cwt.*	*per cwt.*	*per cwt.*	*per cwt.*
PORK :—		*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Home-fed	1	84 0	83 6	88 0	84 0	81 8	88 0	81 8	80 11	88 0
	2	56 0	...	79 4	56 0	...	79 4	56 0	...	79 4
Imported	1	...	...	64 2	...	...	59 6	...	...	59 6

EGGS: Monthly Average Wholesale Prices at Aberdeen Kilmarnock, Lanarkshire and Glasgow.

(Compiled from returns received from the Department's Market Reporters)

Description	Weight per 120	Quality	March s.	March d.	April s.	April d.	May s.	May d.
	lb.		*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Aberdeen—								
Country (ungraded) per doz.	...	1	1	0½	0	10¾	0	10½
	...	2	1	0	0	10	0	10
Kilmarnock—								
Country (ungraded) per doz.	...	1	1	2¾	0	11½	1	0
Lanarkshire—								
Country, "Standard" per doz.	...	..	1	6	1	1¾	1	2¼
Glasgow—								
Unstamped Scottish per doz	...	1	1	4	1	0¼	1	1
National Mark—								
"Specials" ... ,,	...	...	1	3¼	1	0½	1	1
"Standards" ... ,,	...	...	1	2	1	0	1	0¼
"Mediums" ... ,,	...	...	1	1	0	11¼	0	11¼
Ungraded ... ,,	...	1	1	1¼	0	11	0	11
"Specials" ... per 120	...	...	12	7	10	5	10	7
"Standards" ... ,,	...	...	11	8	9	8	10	0
"Mediums" ... ,,	...	...	10	8	9	1	9	1
Ungraded ... ,,	...	1	10	11	9	1	9	1
Northern Ireland ,,	17	...	12	1	10	1	10	3
,, ,,	16	...	11	4	9	5	9	6
,, ,,	14	..	10	7	8	8	8	7
,, (Duck) ,,	...	1	12	7	10	3	8	4
Irish Free State ... ,,	16	...	11	3	8	6	8	6
,, ... ,,	15	...	10	10	8	3	8	2
,, ,,	14	...	10	3	7	10	7	9
,, (Duck) ,,	.	1	11	7	9	6	7	7
Danish ... ... ,,	17	...	13	0	10	0	10	1
,, ... ,,	15½	...	12	2	9	3	9	2
,, ... ,,	14	...	11	1	8	7	8	8
Polish ... ... ,,	..	...	8	6	...		...	

Provisions: Monthly Average Wholesale Prices (per cwt.) at Glasgow.

Description	Quality	March s.	March d.	April s.	April d.	May s.	May d.
		s.	*d.*	*s.*	*d.*	*s.*	*d.*
Butter—Scot. Creamery ..	1	...		...		110	3
Irish Creamery	1	...		...		111	0
Australian	1	101	6	108	0	110	0
New Zealand	1	99	2	107	0	110	0
Danish	1	128	0	117	6	115	0
,, (unsalted)	1	...		...		...	
Dutch	1	103	7	104	6	107	3
Latvian	1	104	10	106	0	108	0
Swedish	1	116	7	110	6	111	3
Cheese—Cheddar	1	88	0	88	0	88	0
,, ,, ...	2	73	0	76	11	80	0
,, ,, Loaf	1	96	0	96	0	96	0
Dunlop	1	86	0	86	0	86	0
Canadian	1	76	0	78	0	78	6
New Zealand (Coloured) ...	1	63	0	70	6	74	9
,, (White)	1	63	0	70	6	74	9
***Farmhouse Cheese**—							
Coloured Cheddar	...	...		...		62	0
White Cheddar	...	...		..		62	0
Dunlop	...	...		...		62	0
†Cheshire	...	...		...		0	6½
***Factory Cheese**—							
Coloured Cheddar	...	...		...		63	9
White Cheddar	...	...		..		65	0
Dunlop	.	...		...		...	
Hams—Irish (Smoked)	1	168	0	172	0	172	0
	2	153	0	157	0	157	0
,, (Boneless)	1	140	0	148	0	148	0
American (Short Cut, Green) ..	1	100	0	100	8	100	0
Canadian ,, ,, ,, ...	1	...		...		...	
Bacon—Ayrshire (Rolled) ...	1	126	0	126	0	124	7
English Wiltshire (Green) ...	1	98	2	101	0	100	6
,, (Dried or Smoked ...	1	106	2	109	0	108	6
Irish (Green, Wiltshire Style) ...	1	93	5	93	9	93	6
,, (Dried or Smoked) ...	1	100	7	101	9	101	6
	2	96	5	98	9	98	9
,, (Long Clear, rolled with skin on)	1	111	5	111	9	112	0
	2	99	2	100	9	100	9
Canadian Sides (Green) ...	1	87	2	92	0	90	9
Danish Sides	1	100	2	106	3	108	0
Dutch (Green, Wiltshire Style)	1	101	7	107	3	108	0
Lard—American	1	74	5	74	0	71	9

* Farmhouse and Factory Cheese Prices quoted are as supplied by the Scottish Milk Marketing Board in respect of Cheese supplied to Brokers. † Per lb.

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter)

DESCRIPTION		QUALITY	MARCH	APRIL	MAY
FRUIT :—					
Apples—					
Irish—	per		*s. d.*	*s. d.*	*s. d.*
Bramley Seedling ...	56 lb.	1	7 10	7 6	10 0
American	case.*	1	13 1	14 5	...
	barrel**	1	22 8	...	...
Australian	case.*	1	...	12 9	12 8
South African	,, *	1	...	15 5	...
Pears—					
Australian	case.*	1	...	..	13 5
Californian	,, *	1	15 2	15 0	..
VEGETABLES :—					
Beet	cwt.	1	5 0	5 0	5 0
Brussels Sprouts—					
Scottish	cwt.	1	13 4	...	...
English	net, 20 lb.	1	3 3	...	..
Cabbage—					
Coleworts	dozen.	1	1 0	1 0	1 4
Red	,,	1	3 0	3 0	3 3
Savoy	,,	1	1 7	1 9	...
Carrots—					
British	cwt.	1	5 1	5 0	5 8
Cauliflowers—					
Broccoli, Cornish ...	dozen.	1	3 10	3 10	3 2
Other British	,,	1	2 11	3 0	2 9
French	,,	1	4 6	4 4	...
Celery	bunch.	1	1 5	1 5	...
Cucumbers	dozen.	1	...	7 0	6 0
Greens	120 heads.	1	10 0	...	...
Leeks—					
Scottish	dozen bunches.	1	2 5	2 4	2 0
English	,, ,,	1	4 6	3 11	3 8
Lettuce—					
Cabbage, Scottish ...	dozen.	1	...	1 9	1 11
,, Dutch ...	,,	1	2 5	2 5	2 0
Onions—					
Spring	bunch.	1	0 6	0 6	0 5¼
Dutch	cwt.	1	4 11	4 6	...
Egyptian	,,	1	...	8 2	6 6
Valencia	case.**	1	12 0	...	...
Parsley	cwt.	1	12 0	12 0	12 0
Parsnips	,,	1	7 0	6 4	6 6
Radishes	dozen bunches.	1	2 0	1 9	1 3
Rhubarb	cwt.	1	31 2	16 6	7 8
Spinach	stone.	1	4 0	3 5	2 6
Tomatoes—					
Scottish	lb.	1	...	...	1 4¼
Canary	,,	1	0 6	0 4	0 4¾
Channel Islands ...	,,	1	...	1 7	1 1¾
Turnips	cwt.	1	1 9	1 9	1 10

* 40 lb. (approx.). ** 9 stone (approx.).

Potatoes: Monthly Average Wholesale Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

Market	Quality	First Earlies	Second Earlies	Late Varieties: Red Soils: Golden Wonder	Late Varieties: Red Soils: Other	Late Varieties: Other Soils: Golden Wonder	Late Varieties: Other Soils: Other
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
MARCH							
Aberdeen ...	1	...	...	...	...	6 1 6	5 3 6
Dundee ...	1	...	...	...	...	7 1 3	5 11 2
Edinburgh ..	1	...	5 8 9	...	...	7 13 4	5 12 9
Glasgow ...	1	...	...	...	...	7 4 0	5 14 0
APRIL							
Aberdeen ...	1	..	...	..	...	7 1 11	5 12 6
Dundee ...	1	...	..	...	...	8 0 0	6 5 0
Edinburgh ...	1	...	...	...	8 0 0	...	6 7 6
Glasgow ...	1	...	...	...	. .	8 0 0	6 0 0
MAY							
Aberdeen ...	1	...	...	...	...	7 6 11	5 11 3
Dundee ...	1	...	...	...	...	8 1 3	6 4 8
Edinburgh ...	1	...	...	...	8 0 0	...	6 13 9
Glasgow ...	1	...	...	...	...	8 0 0	6 7 6

Roots, Hay, Straw and Moss Litter: Monthly Average Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

Market	Quality	Roots: Carrots	Roots: Yellow Turnips	Roots: Swedes	Hay: Rye Grass and Clover	Hay: Timothy	Straw: Wheat	Straw: Barley	Straw: Oat	Moss Litter
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
MARCH										
*Aberdeen ...	1	...	...	...	106 0	...	...	...	37 0	...
†Dundee ...	1	...	...	17 10	142 0*a* 131 0*b*	...	90 0	...	95 0	...
‖Edinburgh ...	1	...	...	...	111 0*a* 111 0*b*	...	65 0	60 0	70 0	...
*a*Glasgow ...	1	...	...	...	115 0	120 0	70 0	...	75 0	45 0*c*
APRIL										
*Aberdeen ...	1	...	...	...	108 9	...	...	...	42 6	...
†Dundee ...	1	...	...	14 3	142 6*a* 132 6*b*	...	91 3	...	97 6	...
‖Edinburgh ...	1	...	...	...	118 9*a* 118 9*b*	...	65 0	60 0	70 0	...
*a*Glasgow ...	1	...	...	...	120 0	125 0	70 0	...	75 0	45 0*c*
MAY										
*Aberdeen ...	1	...	...	...	102 6	. .	...	...	45 8	...
†Dundee ...	1	...	...	13 8	145 0*a* 135 0*b*	...	95 0	...	100 0	...
‖Edinburgh ...	1	...	...	...	120 0*a* 120 0*b*	...	65 0	60 0	70 0	...
*a*Glasgow ...	1	...	...	...	117 6	122 6	70 0	...	72 6	45 0*c*

* Ex farm, loose.
† Baled straw, delivered in town.
‖ Bunched or baled straw, delivered.
a Baled and delivered. *b* Delivered, loose.
c Home moss litter, in 1¼-cwt. bales.

FEEDING STUFFS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	MARCH Glasgow	MARCH Leith	APRIL Glasgow	APRIL Leith	MAY Glasgow	MAY Leith
Linseed Cake—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Home	9 4 9	9 1 6	9 11 3	9 8 2	9 11 11	9 10 0
Foreign	9 3 6	...	9 9 5	...	9 10 0	...
Decort. Cotton Cake ...	9 0 0	9 0 0	9 9 5	9 1 3	..	8 17 6
Undecort. Cotton Cake—						
Egyptian (Home manufactured)	6 1 6	6 2 0	6 9 5	6 8 4	6 8 9	6 10 0
Groundnut Cake, undecort.—						
(40% Oil and Albuminoids)	...	8 15 0	...	8 16 3	...	8 11 8
(50% ,, ,,)	8 13 6	...	8 15 0	...	8 5 0	...
(54% ,, ,,)	8 15 10	...	8 17 6	...	8 6 3	...
Maize Germ Cake, Home mfd.	8 1 11	...	8 13 2	...	8 15 0	...
Rice Meal	7 0 6	...	7 1 3	...	7 0 8	...
Maize Germ Meal	7 5 6	..	7 15 0	...	7 9 5	...
Bean Meal	9 1 9	8 15 0	9 1 11	8 15 0	8 15 11	8 15 0
Fish Meal	14 15 0	14 17 0	14 15 0	15 0 0	14 18 9	15 0 0
Maize Meal—						
Home manufactured ...	7 6 6	7 0 0	8 0 11	7 16 3	7 13 9	7 8 2
Barley Meal	9 12 3	9 5 6	10 3 9	9 18 2	10 1 3	10 0 0
Locust Bean Meal	8 13 0	7 17 6	8 12 6	7 17 6	8 9 5	7 15 8
Locust Beans (Kibbled and Stoned)	7 13 3	7 5 0	7 9 5	7 5 0	7 7 10	6 18 9
Maize Gluten Feed (Paisley)	7 14 3	...	7 15 0	...	7 15 0	...
Maize—						
Plate	6 10 3	6 6 0	7 4 8	7 0 8	6 17 2	6 14 5
African	8 10 0	...	8 12 6	...	8 5 8	..
Oats—						
Home	8 0 0	8 4 6	8 14 5	8 12 6	9 1 3	8 16 11
Barley—						
Imported	8 14 9	8 8 0	9 5 8	9 0 8	9 3 9	8 19 5
Malt Culms	6 17 6	5 15 6	7 0 0	5 13 9	6 6 3	5 6 3
Brewers' Grains (dried) ...	6 17 9	6 8 9	7 0 0	...	6 17 10	6 6 11
Distillers' Malt Grains (dried)	7 4 6	...	7 8 9	...	7 6 11	...
Distillers' Mixed Grains (dried)	7 6 3	7 12 6	7 8 9	7 13 2	7 5 10	7 0 0
Wheat—						
Home	9 15 0	9 11 6	11 0 4	10 16 3	10 9 1	10 5 8
,, (Poultry)	8 18 0	.	10 9 5	...	9 16 3	...
Middlings (Fine Thirds or Parings)	8 2 0	8 0 9	8 11 7	8 4 5	8 8 9	7 18 2
Sharps (Common Thirds)	7 12 9	8 0 6	7 18 2	7 19 5	7 12 6	7 12 6
Bran (Medium)	8 1 6	8 1 9	8 4 1	8 1 3	7 10 8	7 11 3
,, (Broad)	8 7 8	8 11 6	8 9 1	8 9 5	8 3 2	8 1 11
Feeding Treacle	5 7 6	6 0 0	5 7 6	6 2 6	5 13 9	6 5 0
Crushed Linseed	18 10 0	...	18 10 0	..	18 10 0	...
Beans—						
China	8 4 6	8 0 0	8 3 9	8 0 0	7 17 10	7 15 0
Rangoon (White)	7 2 6	...	7 4 5	...	7 6 3	...
Peas—						
Karachi (White)	...	...	...	...	10 10 0	...
Sugar-Beet Pulp (English)	...	6 12 6	7 5 10	6 18 9	7 5 0	7 5 0
,, ,, ,, (Irish) ...	7 1 3	...	7 5 11	...	7 5 0	...
Linseed Oil, per gall. ...	0 4 0	...	0 4 3	...	0 4 3	...

FERTILISERS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	Guaranteed Analysis	MARCH		APRIL		MAY	
		Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Nitrate of Soda*	N. 15.5	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6
Sulphate of Ammonia (Neutral and Granular)* ...	N. 20.6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0
Calcium Cyanamide†	N. 20.6	7 3 9	7 3 9	7 5 0	7 3 9	7 5 0	7 3 9
Nitrochalk* ...	N. 15.5	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0
Superphosphate ...	P.A. 13.7	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0
,, ...	,, 16.0	3 1 0	3 1 0	3 1 0	3 1 0	3 1 0	3 1 0
,, ...	,, 18.3	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0
Ground Mineral Phosphate § ...	P.A. 26	2 15 0	2 12 6	2 15 0	2 12 6	2 15 0	2 12 6
,, ,, ,, § ...	,, 34	3 15 0	...	3 15 0	...	3 15 0	...
Potassic Mineral Phosphate	P.A. 18 Pot. 10	3 16 3	...	3 16 3	...	3 16 3	...
,, ,, ,,	P.A. 20 Pot. 7.5	3 11 3	...	3 11 3	...	3 11 3	...
Kainit (in bags) ...	Pot. 14	3 1 3	3 0 0	3 1 3	3 0 0	3 1 3	3 0 0
Potash Salts ...	Pot. 20	4 2 6	4 0 0	4 2 6	4 0 0	4 2 6	4 0 0
,, ,, ...	,, 30	5 1 3	4 15 0	5 1 3	4 15 0	5 1 3	4 15 0
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	8 2 6	7 15 0	8 2 6	7 15 0	8 2 6	7 15 0
Sulphate of Potash (on basis of 90 per cent purity)	Pot. 48.6	9 15 0	9 7 6	9 15 0	9 7 6	9 15 0	9 7 6
Steamed Bone Flour	N. 0.8 P.A. 28	5 7 6	5 5 0	5 7 6	5 5 0	5 7 6	5 5 0
Bone Meal (Indian)	N. 4 P.A. 20	6 12 6	6 10 0	6 12 6	6 10 0	6 12 6	6 10 0
Basic Slag‡ ...	P.A. 12	2 7 6	1 3 3	2 7 6	1 3 3	2 7 6	1 3 3
,, ,, ...	,, 13	2 9 6	1 5 6	2 9 6	1 5 6	2 9 6	1 5 6
,, ,, ...	,, 14	2 11 6	1 7 6	2 11 6	1 7 6	2 11 6	1 7 6
,, ,, ...	,, 15	...	1 10 6	...	1 10 6	...	1 10 6
,, ,, ...	,, 15¾	...	1 12 6	...	1 12 6	...	1 12 6
,, ,, ...	,, 16½	...	1 15 6	...	1 15 6	...	1 15 6

Abbreviations:—N. = Nitrogen; P.A. = Phosphoric Acid; Pot. = Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

§ Fine grist, 90 per cent fineness through prescribed sieve.

‡ Basic Slag: At Glasgow—80 per cent citric soluble and 80 per cent fineness; F.o.r., in 6-ton lots.

At Leith—80 per cent fineness, no guarantee of citric solubility, *ex* Middlesborough, in wagon loads, carriage varies by from 15*s*. to 17*s*. per ton.

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STATE INTERVENTION IN AGRICULTURE[1]

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FOR purposes of definition, it is desirable to show, in the first place, as concisely as possible, the part occupied by agriculture in the economic structure of the State. The following tables give the essential facts relating to areas, holdings and populations, the output of food from our farms, and the contribution they make to the total food consumption of the people. As a matter of interest, corresponding figures are given for two other countries, Denmark and Norway, which are more agricultural and less industrial than Great Britain. These tables have been very kindly prepared for me by Mr W. H. Senior. Most of the data relating to Denmark have been obtained from Professor O. H. Larsen, and those for Norway from Professor Paul Borgedal; I am much indebted to these gentlemen for their kindness and courtesy.

	Great Britain.	Denmark.	Norway.
Number of agricultural holdings.	(Over 1 acre.) 455,185 (1935).	(Over 1 ha., *i.e.* 2·5 acres.) 204,003 (1935).	(Over 0·5 ha., *i.e.* 1·25 acre.) 208,550 (1930).
Total cultivated land, arable and permanent grass.	29,555,271 acres (1935).	7,975,000 acres (1935) (approx.).	2,500,000 acres (1930) (approx.).
Total population.	44,790,485 (1931)	3,550,656 (1930)	2,814,194 (1930)
Number of people per acre of cultivated land.	About 1·5.	About 0·45.	About 1·1.
Percentage of population in agriculture.	5·7 %. (Workers of total occupied population.)	29 %. (Workers of total occupied population.)	30 %. (All persons.)

The chief facts to note here are the familiar ones, brought out in the last two lines, that in Great Britain the number of persons per acre of cultivated land, 1·5, is relatively high, being three times as many as in Denmark and nearly half as many again as in Norway, while the percentage of the population engaged in British agriculture, about 6 per cent, is very low as compared with 20 or 30 per cent in the other two countries. Notwithstanding the importance and value of our industrial development, this figure of 6 per cent has social and other implications which have exercised the minds of many people and need not be elaborated here.

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[1] Presidential Address delivered to Section M of the British Association at Nottingham, September 1937.

This table shows that, as is again fairly well known, the products of our animal husbandry account for a very large proportion of the output of our land, about 72 per cent. The proportions in Denmark

AGRICULTURAL OUTPUT, 1935

	Great Britain.		Denmark.		Norway.	
	£ Million.	%	£ Million.	%	£ Million.	%
Meat:						
Beef . . .	39·0	16·2	7·4	9·1	1·7	9·1
Veal . . .	3·1	1·3			0·7	3·4
Mutton and lamb	22·2	9·2	0·1	0·1	0·8	4·1
Pork and bacon .	20·8	8·7	25·8	31·9	2·1	11·0
Sub total . .	85·1	35·4	33·3	41·1	5·3	27·6
Dairy and poultry produce, etc.:						
Milk . .	53·9	22·4	30·2	37·3	7·7	40·3
Butter . .	5·1	2·1				
Cheese . .	2·8	1·2				
Cream . .	0·7	0·3				
Poultry . .	5·6	2·3	6·8	8·4	0·1	0·6
Eggs . .	17·8	7·4			1·4	7·5
Wool . .	1·8	0·8	—	—	—	—
Horses . .	0·1	0·0	1·2	1·5	—	—
Live stock and live-stock products .	172·9	71·9	71·5	88·3	14·5	76·0
Crops:						
Cereal, grain and straw . .	13·3	5·5	5·3	6·5	1·1	5·9
Potatoes . .	14·9	6·2	4·2	5·2	1·1	5·5
Other crops . .	11·4	4·8			—	—
Fruit, vegetables, flowers and honey	27·9	11·6	—	—	2·4	12·6
Total crops, etc. .	67·5	28·1	9·5	11·7	4·6	24·0
Grand total . .	240·4	100·0	81·0	100·0	19·1	100·0

and Norway are even higher, and incidentally it may be remarked that in Scotland the figure stands at about 82 per cent. Our milk, it will be observed, is worth much more than our beef; our eggs are more valuable than the whole of our cereal crops put together, and taken along with poultry are fully equal to our mutton and lamb. This table affords much food for thought to those who are responsible for shaping the agricultural policy of the country. The facts it contains and the agricultural conditions it illustrates are indeed of fundamental importance. These facts result from our soil, our climate and the consequent experience and aptitude of our farmers; they are not entirely unalterable, but any policy of improvement, development or control must primarily be based upon them.

The value of the agricultural output per acre of cultivated land is, in round figures, £8 in Great Britain and Norway, and £11 in Denmark. In contrast to this, the annual output per person in British agriculture is about £200, and in Danish about £150.

SELF-SUFFICIENCY IN REGARD TO IMPORTANT PRODUCTS

	United Kingdom.		Denmark.		Norway.	
	1935. Home Produced.	Imported.	1935. Home Produced.	Imported.	Home Produced.	Imported.
	%	%	%	%	%	%
Beef and veal	53	47	100	—	100	—
Mutton and lamb	45	55	100	—	100	—
Pork and bacon	50	50	100	—	100	—
Poultry	(G.B.) 78	22	100	—	100	—
Eggs	66	34				
Milk (liquid)	100	—	100	—	100	—
Cheese	30	70				
Butter	10	90				
Wheat	26	74	7	93	33	67
Barley	46	54	95	5		
Oats	91	9	—	—	—	—
Potatoes	96	4	100	—	100	—

N.B.—Estimates for United Kingdom and Denmark based on quantities, those for Norway on values.

The figures in this third table need little comment and are in a sense a corollary to those in the two previous tables. As regards animal products, the two Scandinavian countries are self-supporting, whereas we produce only about, very roughly, half our requirements of the various kinds of meat, nearly four-fifths of our poultry and two-thirds of our eggs. We produce all the liquid milk we consume, but only 30 per cent of our cheese and 10 per cent of our butter. Of wheat we import about three-fourths of our annual ration and of barley fully half, but we grow over nine-tenths of our oats and nearly all the potatoes we eat.

So much for agriculture as a producer. What about agriculture as a buyer of the products of other industries? Only a rough and possibly unreliable estimate can be given. According to the farm accounts obtained for 245 Scottish farms, of different kinds and in different districts, for the year 1934-35, the estimated expenditure on building materials, implements and machinery, electricity, fuel, chemicals, fertilisers, etc., amounted to from 14s. to 20s. per acre of cultivated land. Admittedly this is a small sample on which to base a generalisation, but, taking it for what it is worth, it would represent a gross total of from twenty to thirty million pounds for the whole country. The corresponding figures per acre are for Denmark 26s. (based on 810 farm accounts for 1935-36), and for Norway from 12s. to 21s.

It may be noted that no allowance is made for the personal purchases of the agricultural population, which presumably would be made, more or less, no matter what the employment of the people might be. The figures represent the purchases of the agricultural industry as such, and show to what extent it is the customer of other industries.

The word ' intervention ' is sometimes used as being equivalent to control. In this paper it has a wider meaning and is intended to cover the various ways in which the action of the State may impinge on agriculture—the ' impact ' of the State on agriculture, to borrow the word employed by Sir Josiah Stamp in his presidential address to the Association last year. Intervention, according to this definition, falls broadly into three categories:

1. Control, *i.e.* statutory compulsion, enforced by penalties.
2. The statutory provision of means by which agriculturists may take voluntary action to do certain things and, in the event of such action, to compel a minority to conform to the wishes of a majority.
3. The giving of direct or indirect assistance, financial, advisory, protective, etc.

Let us first consider control. A complete stranger visiting these islands might receive an impression, perhaps from an agricultural newspaper, or a farmers' meeting, that the agriculturists were oppressed by the rules and regulations of a government that joyed in tyranny, aided by a horde of official tormentors who not only battened on the sufferers but were often accused of being the real inventors of the legislative boots and thumb-screws. The depth and permanence of that impression would depend in the first place on where the stranger came from. If he came from certain European states, the impression might be fleeting; comparing conditions here with those to which he had been accustomed, he might soon say, ' Here is peace: here indeed is freedom.' And if he looked a little under the surface and studied the relation of State and people in this democratic country, he would discover that a government, no matter how inspired by good intentions and a large majority, could rarely if ever pass a law that was unacceptable to the general community, agricultural or other, or, if it succeeded in doing so, would find it very hard to administer it effectively. To legislate in advance of public opinion is no easy matter. Those who have to do with the formulation of legislative proposals, subsequently to be embodied in parliamentary bills, know that an Act of Parliament does not emerge suddenly, fully armed, from the head of Jove. Usually it is only after prolonged discussion and consultation with organisations and individuals that a bill takes shape and gets into sufficient training, so to speak, to run the gauntlet of parliamentary criticism. It is true that a government, having to weigh as best it can the conflicting claims and interests of different industries and sections of the population, may not always meet the wishes of agriculture; but on examination it will generally be found that while it may withhold desired benefits, it seldom if ever attempts to impose an agricultural law to which there is wide and strong objection throughout the industry. The contribution of the civil servant, the so-called bureaucrat, to the legislative process may be one of labour and anxiety, but to call him the real villain of the piece is to flatter him and to ignore the fundamental and very real principle of ministerial responsibility. The British civil servant is truly a servant, informing and advising so far as he reasonably may, but always obeying loyally the government of the day, no matter what its colour or its political philosophy may be. And, if I may say so, British Ministers, of whatever party, do not fail to accord to the Civil Service a corresponding loyalty and that protection from any party criticism without which the Service's impartiality and devotion to duty could not be maintained. The system is the product of a long evolutionary process; it may have defects, but it is at any rate the fruit of the political genius of the British nation. This, however, is something of a digression.

If our foreign visitor were historically minded, he might be interested to look into the past to see how present measures of control compare with some of those to which agriculture was subjected in former days. I have no time in this paper, nor have I the qualifications, to accompany him in any comprehensive study of the subject. One can but glance at a few of the more noticeable instances, in some cases forming precedents or foundations for later legislation. In his *English Farming Past and Present* Lord Ernle says that, 'In the early stages of history, the law itself was powerless to protect individual independence or to safeguard individual rights. Agriculture like other industries was therefore organised on principles of graduated dependence and collective responsibility. Mediæval manors in fact resembled trade guilds. . . .'

These continued until the local and gradual break-up of the manorial organisation of agricultural labour was accelerated by the Black Death (1348-49). Labour became so scarce that panic wages were asked and paid until in 1349 by Royal Proclamation all men and women 'bond or free,' unless tilling their own land or engaged in merchandise or in some other craft, were compelled to work on the land where they lived at the rate of wages current in 1346.

Here, nearly 600 years ago, was wages regulation of a pretty drastic kind, but it was a maximum that was fixed, not a minimum. Later on, in 1563, we find another notable effort to control the labour market in the Statute of Apprentices, which enacted, *inter alia*, that all persons between 12 and 60, not exempted by the statute, could be compelled to labour in husbandry and that masters unduly dismissing servants were fined and that servants unduly leaving masters were imprisoned. It also stated hours of labour and provided for the fixing of wages by Justices of the Peace.

The story of land enclosure is well known and need only be mentioned as an illustration of State intervention, operating first in one direction and afterwards in another. In the sixteenth century, land enclosure, involving 'the break-up of mediæval agrarian partnerships and a substitution of private enterprise for the collective efforts of village associations,' was opposed and partly arrested by legislation; in the eighteenth century it received from Parliament encouragement and support. Many individuals suffered, but the ultimate benefits to agricultural production and to the State as a whole cannot be denied. It is interesting to note that in 1589, in order to relieve the labourers who lost their livelihood through the enclosure of land for pastoral purposes, it was enacted that not more than one family was to occupy each cottage, and to each cottage 4 acres of land were to be attached. The recent movement to provide allotments or small pieces of land for unemployed industrial workers seems almost like a faint echo of that distant law.

As an example of compulsion indirectly benefiting agriculture, one may cite the law passed early in the seventeenth century making it a penal offence for any person over the age of six not to wear on Sundays and holydays a cap made of English cloth. Later, in 1666, the law did not stop short even at the gates of the churchyard, for it required that the dead should be buried in shrouds of home-grown wool. In passing, it may be noted that about the same time the Government, 'for the sake of multiplying seamen,' had ordained fast-days on which only fish was to be eaten. With precedents of that sort before us, we are almost tempted to long for an Act making the consumption of oatmeal, milk and herrings obligatory, and the possession of a tin-opener a criminal offence; it would solve several current problems of Scottish agriculture and fisheries.

Legislation of another kind prevailed throughout the eighteenth century, when home production was encouraged by the placing of a duty on the importation of foreign corn and the payment of a bounty on exported corn, combined, however, with frequent prohibitions of exports. Similar laws were enacted to encourage the raising of cattle, and importations from Ireland were prohibited. But legislation, says Lord Ernle, did not raise prices; it only succeeded in maintaining them. Increased production at home counteracted the effect which limitation of imports was designed to produce. It is unnecessary here to retell the story of the corn laws and of their repeal, or to touch on more recent fiscal controversies.

The earlier instances of State intervention that I have cited were all English, but the Scottish parliament also provides us with some interesting examples. With regard to labour, the extinction of serfdom having been considered productive of indolence, a statute of 1424 required cottage holders to perform a certain amount of labour on the land, a provision for which we have had an English parallel. At almost the same date, 1426, we find parliament taking partial control of cropping. To secure a greater variety of crop than the oats and bere which were chiefly cultivated, it was enacted that every man tilling with a plough of eight oxen should sow every year at least a firlot of wheat, half a firlot of peas and forty beans, ' under the payn of ten shillings.' At a much later date, 1703, a curious Act relating to cultivation was passed, forbidding any butcher to have more than one acre of land for grazing unless it be tilled annually, under penalty of £100 Scots for each offence, loss of the cattle found grazing and loss of the freedom of the burgh. Public health and amenity were not overlooked, for to improve the aspect of the country, check malaria and provide shelter, all freeholders were required (1457) to plant on their land trees, hedges, and broom. Nearly two hundred and fifty years later (1695) an Act for the preservation of meadow lands and pasturages near sandhills forbids the pulling up of bent, juniper and broom.

The necessity of keeping down weeds was recognised in the statute which required the cleansing of land from ' guld,' *i.e.* marigold. The Act, with a touch of humour now sadly lacking in modern statutes, sets forth that anyone who planted ' guld ' deserved punishment as amply as if he had led an army against the king and barons.

Pig-feeding was discouraged. No burgess could permit swine to remain in the fields without a keeper and they had to be kept out of plantations and hunting ground, while it was decreed by Parliament that the owner of a hog which made a hole in a meadow or open place should be compelled to fill the hole with grains of wheat.

Security of tenure is a subject of which we still hear. In the middle of the fifteenth century (1449) there was passed what might almost be called the first of the Agricultural Holdings Acts. It provided that ' for the safetie and favour of the puir pepil that labouris the grunde, that thay and all utheris sall remaine with their tackes unto the ischew of their termes, quhais hands that ever thay landis cum to.' In other words, a change of ownership of the lands did not involve the dispossession of the sitting tenants. Our present law restricting the period for ' making muirburn,' *i.e.* heather burning, goes back, with some difference of the dates, to at least 1400.

Storage of grain, a measure now advocated by some for purposes of defence, was not considered desirable in the fifteenth and sixteenth centuries, for in 1449 it was enacted that ' to prevent dearth,' no old stacks of corn were to be kept in the yard after Christmas; in 1452 the date was extended to the end of May; and in 1563 to the 10th of July.

These few examples of how in the past the State has laid its hand, sometimes heavily, sometimes helpfully, on agriculture are obviously very far from exhaustive and are not intended in any way to constitute a historic survey. They have been selected almost at random, to show that intervention—call it interference if you will—however much we may think we suffer from it to-day, is no new thing. You will observe that the intervention was almost all of the compulsory kind, the single exception among the instances quoted being the Scottish Act conferring a degree of security of tenure. My second category is not represented and there is no bestowal of direct benefits such as subsidies, etc.

Having glanced at some precedents, let us consider the present state of affairs. We are all, of course, subject to State control of various kinds; we must educate our children, pay income-tax, drive our cars carefully, refrain from buying or selling certain goods after certain hours, and so on. Some people think we have far too much of such control, others find their yearnings still unsatisfied, and are eager to kiss, or to see others kissing, almost any new rod. There are, indeed, probably few of us who could not mention some objectionable thing that other people ought not to be allowed to do. But here we are considering not the common burdens that have been laid upon all citizens, but only those special ones that have been imposed upon the agriculturist as such. I am not going to trouble you with a catalogue of Acts of Parliament, nor need I refer to the various compulsive or restrictive measures of war-time. It will be sufficient to mention some of the existing laws in my first category that come most readily to mind.

The farmer is bound to furnish to the Government annual statistical returns of his crops and live stock. For many years the returns were made voluntarily, but since 1925 they have been compulsory. The filling up of forms is one of life's minor worries, but no one can deny that the compilation of accurate agricultural statistics is essential for the proper understanding of many of the major agricultural questions with which the Government and the farmers themselves have to deal.

The Contagious Diseases of Animals Acts, administered for the whole of Great Britain by the Ministry of Agriculture and Fisheries, may at times interfere seriously with the activities of the farmer as a stock-owner, but without them he would undoubtedly be exposed to vastly greater and possibly catastrophic losses. Similarly, the Destructive Insects and Pests Acts may occasionally hamper him as a crop grower, but on the other hand they afford him protection with which he would not willingly dispense. These two laws are in fact more protective than restrictive, and I have never heard any one suggest that they should be repealed.

As a breeder of horses and cattle, the farmer must conform to the requirements of the Horse Breeding Act and the Licensing of Bulls Act, which are designed to prevent the use of inferior sires. Here again agricultural opinion is, in general, entirely on the side of the law; representations have, in fact, been received from responsible quarters that the principle should be extended to pig-breeding.

A statutory system of prescribing and enforcing the payment of minimum wages to agricultural workers has been operative in England since 1924, and Parliament has recently passed an Act introducing a similar system into Scotland, where at the time of the passing of the English Act, and for several years after, the workers themselves, as well as the farmers, were opposed to having such legislation. Here perhaps we come to a subject not quite free from controversy. But if it be accepted that without such legislation there is a danger that the pay of the worker might fall below the amount necessary to maintain him and his family in a reasonable degree of comfort, there are few who would deny its justice. Criticism of the law has been based not, I think, on this ground, but rather on the ground that certain other steps should be taken to enable the farmer, in his economic difficulties of recent years, to pay a satisfactory wage. The criticism, so to speak, has been consequential rather than direct; there has been little opposition to the fundamental principle embodied in the Acts.

The Corn Production Act is remembered with mingled feelings. One solitary vestige of it remains in operation, the section requiring the destruction of certain specified weeds. As these are weeds which, if unchecked, may spread far and wide, there need be little sympathy with the delinquent who permits them to grow, to the detriment of his fellow-farmers.

Under the Milk and Dairies Acts, the dairy farmer, in the interests of public health, has to conform to certain standards of cleanliness, accommodation, equipment, etc.

Certain restrictions, not very onerous, are laid on farmers by such Acts as the Animal Anæsthetics Act, the Dangerous Drugs Act, the law relating to Heather Burning in Scotland, the Slaughter of Animals Act, and some others which may occur to you.

Whether the State presses more or less heavily on agriculture than on other businesses, *e.g.*, shipping, mining, manufacture, shops, railways, etc., I am not in a position to estimate; but later in this paper I shall venture on the opinion that the farmer is perhaps fortunate in that the hand of the law does not hold him in a tighter grasp than it does at present.

I come now to my second category of State intervention: that in which the State does not at first hand compel or prohibit, but gives farmers the opportunity to organise themselves for certain purposes and, should the necessary majority of producers decide to avail themselves of the opportunity, empowers them to secure conformity by the minority and to impose penalties on recalcitrant or erring individuals. The Agricultural Marketing Acts are the only laws that come strictly within this definition, although the Agricultural Produce (Grading and Marking) Act is similar in that the adoption of the National Mark under it is permissive, but when it is adopted it conveys a statutory guarantee of quality, with penalties for mis-use. As you know, the Marketing Acts are a recent institution in this country. Hitherto, agricultural co-operation for the marketing of agricultural products had been on an entirely voluntary basis, with the advantages and disadvantages inherent in such a system: on the one hand, complete freedom of the individual, and on the other the danger that the desires of a majority might in practice be frustrated by a minority who, for various reasons—personal gain, short-sightedness, secretiveness, love of individual independence—were unwilling to observe the rules and limitations necessary to secure successful collective action. But under the Marketing Acts, co-operation can be fortified with some very effective artillery. Fundamentally, however, the principle is still voluntary and the system democratic. Unless the required majority of the producers of a certain commodity vote in favour of the marketing scheme submitted to them at a poll, the Government has no power to impose a scheme upon them. In Scotland, for example, two raspberry marketing schemes have been rejected at the poll, and there the matter ended. And should a scheme be adopted and approved by Parliament, it is administered by a Board elected by the registered producers themselves.

The need for improved marketing methods in this country is widely, if not universally, admitted; the economic dangers and disadvantages to the farmers of the indiscriminate sale of their goods in haphazard quantities and of irregular quality by hosts of unrelated producers have been only too apparent in the past; and the weakness of purely voluntary co-operation as a remedy has been illustrated more than once. (The comparative failure of the Scottish Milk Agency scheme may be cited as an instance.) In view of all this, the difficulties and controversies to which the Marketing Acts and their derived schemes have given rise may be a matter for some surprise, but only, I think, to those not familiar with all the facts. One fact is the strong individualism of the British farmer, begotten of tradition, experience, and his whole way of life. Sometimes in the modern world, individualism may be a handicap; but the modern world too can show us many instances in which its absence is even more to be deplored. In this country most of us still believe that, in the words of John Barbour, 'Freedom is ane noble thing.' We must, however, retain our sense of perspective, and it is possible to exaggerate the degree of subservience to which farmers are subjected by a scheme which a majority of them was free to accept or reject and which, when accepted, is administered by their own representatives. Another and an important fact is that the marketing schemes are of a novel and necessarily complicated kind. Experience has to be gained, experiments have to be made, the engine has to be run in, mistakes in driving, sometimes serious mistakes, are inevitable for a time. Patience and tolerance are required. It is better surely to adjust the bearings and tighten loose nuts than to throw the spanner into the works and wreck the whole machine. For even the critic must admit that the Acts and the schemes are at least earnest attempts to remedy serious defects in one important side of British farming.

The subject is being treated in a separate paper this morning and I do not propose to discuss it in any further detail. But I will conclude my reference to it by quoting the opinion of one authority who has written: 'The Marketing Acts are the equipment for a great experiment in the possibility of farmers organising their industry themselves, with due regard to the interests of the consumers. If the experiment succeeds, it may postpone indefinitely such drastic changes in the structure of agriculture as those which are taking place in Soviet Russia. If it fails, not less but more control will be inevitable.' How many of you will agree with that view I do not know.

Having considered briefly the methods by which the State helps the farmer by laying restrictions on him for his good, and by handing him the keys with which to open, if he will, the palace called Organised Marketing, where the enchanted princess, disguised as the British housewife, awaits him, let us now, in the third place, glance for a moment at the other ways, some of them quite direct, in which he is aided and supported. Fortunately, it has been unnecessary for me to seek out all the facts from the numerous and sometimes rather elusive official publications and records in which they are contained, for that difficult task was most ably performed two years ago by Dr Venn, to whose address I refer you. At the levels then current, the gross total of financial assistance afforded to agriculture, including forestry, and allowing for local taxation reliefs, amounted to upwards of thirty-three and a half million pounds, from which he deducted ten and a quarter millions representing the debit caused by the action of the Wages Committees, thus bringing out a net gain of about twenty-three and a half millions. Some adjustment of these figures is required at the present date. Owing to the rise in the price of wheat, the wheat subsidy, which as you know is not a direct Treasury grant but is obtained from the consumers of flour, is at present negligible. On the other hand, the cattle subsidy now stands at five millions instead of three and a third and sums amounting to a maximum annual total of £3,490,000 have lately been promised in respect of oats and barley, lime and basic slag, land drainage and the reduction of live-stock diseases. In his balance sheet, Dr Venn, no doubt wisely, made no allowance for the option afforded to the farmer of being assessed for income tax on his rent instead of on his actual profits, should these prove to be the greater. What that special concession is worth, it is impossible to estimate, but with any improvement in the financial position of the industry its value progressively increases.

The items in the balance sheet, apart from the recent additions which I have mentioned, are, as you may remember, wheat, beet, meat, milk, land settlement and allotments, afforestation, local taxation reliefs, and administrative and development services. This last is a comprehensive item embracing many and varied matters such as live-stock improvement, land drainage, etc., and including the subjects which are of special interest to many members of this section, Education and Research. For the financial year 1912-13, the State grants for these subjects amounted to £65,750 in England and Wales and £34,889 in Scotland, a total for Great Britain of £100,639, whereas in 1936 the corresponding figures were £628,570 in England and Wales, and £136,769 in Scotland, a total of £765,339.

These are large and striking increases, but it must be remembered that for many years our standard of expenditure on these services was much lower than that in several other countries, so that if we were to attain, as we have done, fairly adequate recognition of their importance within a reasonable time, a steep financial ascent was inevitable. In view of the interest in the subject, it is tempting to ascertain whether this growing outlay has been reflected in an increased yield of agricultural products. The question, however, is not an easy one to answer, since many factors are at work, and it is difficult to ascribe an increase to any particular one. The output of live-stock products, for example, must depend very largely on the prices of imported feeding stuffs. Possibly the least fallacious measure to apply is the average yield per acre of our principal crops, though here again the problem is not simple. For instance, if the total acreage of a crop falls, the average yield per acre tends to rise, since it is from the least suitable land that the crop will be withdrawn; conversely, an extended acreage will probably mean a somewhat smaller average production. It is subject to this and other qualifications that the following table should be taken as providing any indication of the effects of our education and research. The figures are for 35 years from 1900 onward and are given as quinquennial averages, so as to smooth out to some extent annual fluctuations due to weather conditions, etc.

In Great Britain as a whole, wheat, the acreage of which has fallen since the war years, shows no significant increase, oats are up by 4 or 5 bushels and potatoes by something like half a ton, but rotation hay has made no advance in spite of a reduced acreage. The results are not spectacular, but the economic difficulties of many farmers, in the later periods, must be kept in mind. Any variations are, however, in the right direction, and striking changes in averages for the whole country could hardly be expected. A general rise in national production is bound to be a slow movement. But there are doubtless considerable numbers of the more progressive farmers who, by availing themselves of the aid offered by the scientist, have obtained increases much in excess of any shown in the table. It has to be remembered, too, that even where yields have not increased, costs of production may have been substantially reduced.

There are some other branches of State intervention which, notwithstanding their importance, it must suffice just to mention: protection of the farmer by means of import tariffs and quotas, designed to raise or maintain the prices of his products; the Agricultural Holdings Acts, controlling the relationship of landlords and tenants; land settlement legislation, which enables new holdings to be established on land which, under certain conditions, may be compulsorily acquired for the purpose.

In the course of an hour's address it is not possible to do more than take a hasty glance at this large subject, with its many

Period.	Wheat.	Oats.	Potatoes.	Rot. Hay.
1900-04				
Acres	1,645,774	3,094,642	569,399	2,331,575
Yield	*29·83 Bushels*	*39·24 Bushels*	*5·65 Tons*	*29·50 Cwt.*
1905-09				
Acres	1,725,616	3,061,529	572,176	2,179,882
Yield	*33·28 Bushels*	*40·56 Bushels*	*6·20 Tons*	*30·23 Cwt.*
1910-14				
Acres	1,852,994	2,964,502	585,842	2,041,321
Yield	*31·28 Bushels*	*38·50 Bushels*	*6·29 Tons*	*28·76 Cwt.*
1915-19				
Acres	2,227,592	3,428,908	650,973	1,989,169
Yield	*30·56 Bushels*	*39·18 Bushels*	*6·19 Tons*	*29·10 Cwt.*
1920-24				
Acres	1,879,088	3,107,942	666,289	2,124,750
Yield	*31·94 Bushels*	*38·30 Bushels*	*6·18 Tons*	*28·92 Cwt.*
1925-29				
Acres	1,546,255	2,725,711	646,886	2,000,654
Yield	*32·36 Bushels*	*43·38 Bushels*	*6·48 Tons*	*28·38 Cwt.*
1930-34				
Acres	1,516,509	2,428,413	614,942	1,884,938
Yield	*32·20 Bushels*	*43·56 Bushels*	*6·56 Tons*	*28·58 Cwt.*

interesting ramifications, any one of which might well have a whole volume to itself. But inadequate as the survey has been, there are one or two deductions that may perhaps be drawn from it.

Comparison of an agricultural country like Denmark with an industrial country such as ours must not be carried too far. Marketing and other organisation, opportunities of alternative employment, standards of living, necessarily differ in the two countries. But allowing for all this, the statistical tables quoted in the earlier part of the paper suggest that British agriculture at present falls short of producing as much home-grown food as is possible and desirable for the nutrition of the people and also of affording employment on the land to as many persons as is reasonably practicable. The need of higher nutritive standards for a number of our population and the importance, in attaining these standards, of larger supplies of certain foods, in the production and marketing of which our farmers have some natural advantages, are now generally recognised. This recognition is tending to encourage the development of certain branches of our agriculture and it is to be hoped that the process will be a progressive one. Some authorities seem to consider that the sole impetus required to accelerate the process is to increase the purchasing power of the lower-paid groups of the population. That is certainly a factor of much importance, but there may be need too for education in the principles of nutrition, not only among these groups, but among some others as well. This aspect of the matter will no doubt be kept in mind should it be thought advisable to devise schemes for securing the desired object.

When speaking of the greater employment of the people on the land, one is apt to be reminded at once, and quite properly, that, thanks to the activities of the scientist and the engineer, the output per unit of agricultural labour is steadily rising. This is a tendency that can be neither ignored nor retarded. Increased production, therefore, may not necessarily cause increased employment. But, on the other hand, it is probably true that it will be long ere, in this country, the large-scale mechanised farm, the ideal of the economist, is the general and normal agricultural unit. And, given reasonable prospects of even moderate commercial success, there are many for whom rural life holds a fascination and independence denied to the townsman and the factory worker. For agriculture, as has been said, notably by Professor W. G. S. Adams, in his paper read to this Section at Aberdeen, is not only a living, but a way of life. To live in that way, they are willing to risk the financial vicissitudes of the farmer or even to undertake the arduous labours of the small-holder. Cynics may call it sentiment; it is none the less a fact. But the question is by no means entirely one of settling people in new holdings; at present it is indeed rather one of making up leeway both in land and in the people employed on it. Since before the war, two million acres have gone out of arable cultivation. The reclamation of waste lands in England, the repopulating of our Scottish glens are perhaps less immediately possible, but is it too much to hope that at least a good part of these two million acres might be recovered? Were it solely a matter of farming economics, the shrinkage of our cropping area and extension of our grass-lands might perhaps be regarded with equanimity, especially if the grass were of reasonably good quality. But wider issues are involved; the effects on employment and food production cannot be left out of account.

In the second place, when one compares the amount of control to which agriculture is subjected by the State and the amount of benefits, direct and indirect, which it receives, one cannot fail to notice some disparity between the two. The State is paying the piper fairly substantial sums, but while it exercises a little restraint over some of his actions, its only method of calling the tune is to offer special rewards for certain specified melodies. Some people may say that the payments should be larger, or different in form or in distribution; others perhaps may think that with so much foreign music available, it does not greatly matter what our piper plays. But at any rate the fact is that the selection of the tunes is ultimately determined only by individual choice. And one can hardly help asking, somewhat anxiously, whether, if the system of payments, in their various forms, is to be continued or extended, the freedom and independence of the piper can be maintained. To drop the metaphor, if it be the policy of the State to preserve and support the farmer, at considerable cost, is he to cultivate and crop his land, to produce meat or milk or other products, as he thinks best, without any dictation as to methods, quantity or quality? I would emphasise that the question is not whether the farmer should be supported and protected, but only whether there is a possibility that, sooner or later, certain consequences may follow from that policy. It is true, as I have said earlier, that it is difficult for a Government to pass and to administer an unwelcome law; but if Government aid were made conditional on Government control, the farmer, however distasteful he found it, might be induced to swallow the pill for the sake of the gilding.

It may be argued that the State, in return for its expenditure, whether in the form of direct payments or of artificially raised prices, is entitled to demand not only certain goods, but a certain standard of performance, a view that found expression in Part IV of the Corn Production Act, which gave ‘ Power to enforce proper cultivation.’ In response to that argument, it may be claimed that if the farmer is to be bound to produce commodities of a kind, quality and amount determined according to the kind and area of his land, he should be insured against any loss incurred in the process. And that leads to the further question: if he is to be insured against loss, is he to be left free to make unlimited profits, should his efforts prove successful? It is easy to follow out this line of thought and to see complete control, including rents as well as wages, following in due course, and, indeed, the ultimate incorporation of every agriculturist in the Civil Service! *Timeo Danaos et dona ferentes!* Possibly this is all merely academic speculation, but given the promise of State support, the subsequent reasoning does not seem to be entirely fallacious. Whether the conclusion, if it were ever reached, would be a desirable one, is a matter for individual opinion.

Thirdly, it may be noted that, while some of the State benefits, *e.g.*, rating relief, the fruits of education and research, etc., are bestowed upon all, certain others, *e.g.*, the wheat and beet subsidies, are, owing to natural conditions, not universally available. This is a thorny subject—although not quite so prickly as it was a few months ago—about which some of us have heard a good deal in the last year or two. The State is, of course, entitled to pay for those commodities the production of which it wishes to maintain or increase, or to come to the rescue of those whom it deems most needful or deserving of succour. If, for instance, a ‘ nutrition ’ policy required an increase of, say, meat, or milk, or fresh vegetables, or if the agriculture of one part of the country were, for some reason, in special jeopardy, the disbursement of funds for such purposes would appear to be perfectly legitimate. But if it were a permanent policy for the State to support British agriculture in general, it might perhaps be desirable to survey the whole industry, its place in the social and economic structure of the country, its present and potential capacity to meet the food requirements of the people, and its relation to international trade. These subjects are no doubt being studied now, but it can hardly be claimed that the study is complete. Perhaps it never can be completed, for many of the factors are far from static. But if a comprehensive, reliable and possibly continuous survey could be made, it might form the basis on which State aid might be allocated equitably, from time to time, to those branches of the industry which it was desired, in the public interest, to encourage and in proportions according to their needs. But on this assumption, the shadow of State control still lurks darkly in the background.

This leads one, lastly, to consider whether in State aid, with its attendant shadow, lies the only hope for British agriculture. The question is one of paramount importance and of formidable difficulty, on which any one should hesitate to dogmatise. But for some at any rate there would be comfort in the belief, if they could hold it, that our farmers, given a fair share of our home markets, could once more struggle through their difficulties and maintain their position by their own initiative, energy and resource. For many of them, times have been hard, but many too are riding out the storm with courage and success. Observation, supported by careful economic investigation, shows that the personal factor is still one of enormous importance. Within one parish, even on neighbouring farms, great disparity in farming practice and results may be found. The man of enterprise and adaptability, the man who is eager to acquire new information, to test new methods in the light of his practical experience, and to apply his mind to the business management of his undertaking, he is the man who is least clamant for State subvention to help him in balancing his accounts. Education and research, both scientific and economic, have yet many gifts in store, gifts the acceptance of which carries no penalties. If they be accepted willingly and applied diligently, is it not possible that the general standard of our farming might be raised to a level at which it would be beyond the reach of any, save the very heaviest, waves of depression? If not, there seems to be at least a risk that our farming, no longer the free industry that we know and respect, may become a mere hanger-on of the State, dependent on its bounty and subject to its commands. Economic independence is worth a struggle, for with it may go a higher kind of freedom that is worth the hardest fight of which man is capable.

THE ENCOURAGEMENT OF BETTER PLANTS IN PASTURE[1]

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THE possibility of increased production from our land is the theme of much discussion at the present time. It is certainly true that much of our grassland is producing far less than it might.

Several reasons may be found to account for this, but a very forcible one is that some of the practices of long standing in the farming of grassland have during recent years left the farmer without adequate recompense. Hence it has been necessary to make certain changes in practice. In many cases these changes have proved useful for two or three years and then have left not only the farmer but also the grassland itself in a worse position. This is the case where the feeder has reduced his spring outlay on store cattle in order to meet the low returns of the spring and summer beef trade. Here is a case of variation from the original standards of good husbandry; its influence on the grassland, on its fertility and other characters determining its future productive capacity, needs therefore to be studied if such deterioration is to be checked in a practical and economic manner.

The essential purpose of pastures is that the herbage plants growing in them should be grazed. Hence it is of importance to know how such plants respond to animal 'interference'—for grazing is an interference in the plant's own economy.

Plants respond to their environment at all times and their rate of growth is retarded when they are subjected to such adverse conditions as cold weather, lack of moisture or lack of food supply. The most important factor affecting our pastures is the regular rhythmical influence of season with its extremes of cold in winter and heat in summer. In our temperate climate most of the plants found in pastures are perennials which quicken into active growth in the spring, produce, if left undisturbed, flowers in the summer, and after ripening their seed make a little further vegetative growth in the autumn. The season's growth is divided so that the surplus store accumulated by the plant in the spring is largely utilised for spreading its progeny, whereas that accumulated in the autumn is retained for the purpose of maintaining the plant itself over the winter and then assisting it to start in the following spring with an advantage over its neighbours in the all-pervading struggle for food.

Now if a pasture were composed of only one type of plant the animal by its act of grazing in the spring would reduce the plant's efficiency at that stage and thus check its increase in size and ultimately its yield of seed. Similarly by grazing in the autumn the animal would reduce the store set aside by the plant for the following spring. This limitation would be reflected in the vigour of its growth at that critical period, the commencement of its spring growth, when it should be putting out new roots as well as new shoots. In effect the grazing as such would tend to check the growth at all stages.

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[1] Paper read before Section M of the British Association at Nottingham, September 1937.

But the effect of interference by animals is not all on the adverse side. They serve to make the plant nutrients circulate rapidly. About 80 per cent of the ingredients such as lime, phosphates, nitrogen and potash taken in by the grazing animal are returned within a few days to the soil in the animal excrements in a form that the plant can readily take up. Thus in the course of a growing season—March to October—such constituents might pass through the complete circuit of plant-animal-soil as many as three or even four times, on each occasion carrying with them extra carbohydrates in a highly digestible form. In the case of hay, on the other hand, such a circuit is completed only once a year, while in that of a fibrous matted pasture it may take ten years.

Grazing by animals thus checks the rate of increase in the size of the plant, affecting the formation both of leaf and of stem, but the plant is to a large extent compensated through their excrement.

Besides influencing the size of a plant animals change its form, more particularly the number and size of its tillers. When a plant is putting up new shoots in the spring—tillering—the rate of increase in tillers depends on its environment at the time; the more favourable the weather and the more plentiful the supply of food the greater the number of new shoots developed. About the month of May, however, this increase generally stops, probably because the earlier formed tillers deplete the general pool of the plant while they are putting up their stems and flower heads. Now if these forward shoots are removed, *i.e.*, if they are prevented from putting up their stems, the plant will continue to increase its number of tillers far beyond the previous limit. In fact it will adjust its number of shoots once more to the degree of favour afforded by its environment at that particular time. Since the weather and the availability of the plant food are usually more favourable in May than in April the number of tillers will probably, therefore, be doubled, thus producing a denser sole.

The pasture so far dealt with, containing but one type of plant, may be described as a ‘ freak ’ pasture. In most of our pastures, especially if they have been down for more than two years, there are various types of plants competing with one another for food. The success of a particular type depends to a large extent on its reaction to the grazing animal.

Some plants grow more quickly than others and it is common knowledge that in sward competition, just as in a race, the more rapidly growing species thrive most and win, that is where there is no animal interference. If, however, animals are continually nipping off the new growth they subject the plant to a drain on its resources, the new leaves being produced at the expense of the reserves within the plant itself and then being removed before they can make any recompense. Under such a strain, and this often happens in pastures, the more rapid growers would be the first to suffer.

So in what might be termed ordinary growing periods the animal by its grazing tends to set the balance in favour of the slower growing plants, *i.e.*, the least useful ones.

But let us take this a step further and see what happens when the animal is obliged to graze down really close. This often happens during a spell of weather adverse to growth, such as drought. Most grass plants very soon close down, *i.e.*, they stop active growth and not only that but they soon reduce to a very low proportion their living aerial portion. Other plants, notably Cocksfoot, will persist in growth for a much longer time before they stop producing new succulent leaves. Under such conditions the Cocksfoot if left unhampered will gain ground from its competitors. Here one would say we have a useful plant against drought. But what happens if animals get access to such plants at this critical time? They will remove the succulent leaves and then in a few days come back for the new leaves put up under these adverse conditions to replace those leaves taken away. In a few days more they come back again for the third batch of new leaves. This means that the store laid aside by the plant is soon exhausted *because* the plant possesses a character making it particularly useful for such a dry period, and later on it will have to suffer, because those plants which had closed down early will at least have conserved their resources for use during the resumed struggle when the drought is over.

The animal therefore changes the relation of a plant to its environment. The Cocksfoot instead of gaining an advantage over its neighbours by growing when they were dormant suffers the full brunt of the animal's attack and that at a time when it is more difficult for it to recuperate between the grazings.

A similar fate befalls the early starting ryegrasses in the spring. During any short intervals of comparatively mild weather that may occur in February or March these grasses—Italian Ryegrass and Perennial Ryegrass—put up more new leaves than most of the other varieties usually found in a grazing sward. In fields closed up from the beginning of the year until the middle of April this gives them an advantage and they tend to increase. Where, however, animals have access to them during the hungry period of February and March they are severely punished, and they usually succumb after two or three years unless special care is taken to protect and encourage them.

Plants may be found growing under adverse conditions other than those of weather, and their response to animal interference will vary with the circumstances. As a general rule it may be taken that a prostrate plant like Wild White Clover is more favoured in a pasture the more that pasture is grazed, since the animal prevents the taller growing species from overshadowing it. The animal in fact helps to make the sward an ideal place for the White Clover. Where, however, the plants in a pasture have been allowed to grow tall during the summer for two or three seasons through undergrazing or complete lack of grazing, the Wild White Clover plants that were originally present will adapt themselves to these adverse conditions by changing their mode of growth. Instead of producing their usual large number of leaves on short stalks they will produce far fewer leaves, but these will develop long stalks so as to thrust the tripartite leaf above the general mass of other growth and thus secure the necessary light. With such a temporary modification the clover can tide over adverse spells of limited duration, say two or three years.

If, however, such land is stocked lightly during these years the chances of the White Clover's survival will be very much less, because the animals will be able to get at almost all the assimilating tissue of such clovers and finding them more palatable will concentrate on them. This selective grazing does not reduce the growth of the other plants to anything approaching the conditions under which the clover could resume its normal mode of growth. Thus under conditions most normal for the growth of Wild White Clover the animals help the clover whereas under conditions abnormal for that plant the presence of animals serves to check it.

Nor does selective grazing, in such a case of under-stocking, affect only clover. An animal given a superabundance of food supply at any time will consume the more palatable plants so long as they are present, whilst the unpalatable plants are allowed to increase all the more through the discouragement of the palatable ones. This is just the reverse of what the farmer would wish.

We must, however, revert to what was said above of the restoration of plant nutrients by grazing animals to the soil in a readily available form. The plants that will get the bigger share of this supply are obviously the ones that are growing more quickly at the time. Thus in April Perennial Ryegrass is found dominating round the dung pats of winter; Cocksfoot and Yorkshire Fog are the species commonly found in June and July round the dung pats dropped during the flush growth at the end of April and during May; and the first species to creep during August and September into the dried-out dung pats of the summer is Wild White Clover.

But in this matter of compensation how often do we find Nature paying her debt to the one she robbed? That is not her way. The grazing animal usually requires water to drink after it has taken its feed and wanders in search of it. Afterwards it takes a quiet rest, in the course of which will be intervals of chewing the cud. At any rate before starting off in search of another feed later on, the animal passes on the manurial ingredients to the land adjoining the water supply or to land favoured in some other way such as the presence of shelter in winter or a cool breeze in summer. This land frequently receives such a quantity of droppings as to soil the feed, making it so objectionable that the manurial ingredients are to all intents and purposes wasted.

The robbing of large areas by such uncontrolled grazing (including uncontrolled distribution of manure) leads to a deterioration of the soil and hence of the pasture out of all proportion to what is caused by the removal of soil ingredients in the carcases and wool of stock raised on such areas. This is why adequate water supplies and fencing play so important a part in the management of extensive tracts of so-called pastures. If the grazing stock is not suitably controlled the depletion of fertility on such areas would be checked by intervals of no stocking, whereas under more normal conditions with the droppings returned fairly uniformly over the land the heavier the grazing stock the greater the accumulation of fertility.

I have tried to show how the animal robs its pasture in certain ways and helps to improve it in other ways. It remains now for us to examine how the farmer can make use to advantage of what grows on the pasture without at the same time spoiling that pasture for future production.

Though it is usually accepted that the most serious fault in the treatment of most of the pastures in this country to-day is understocking, it must be remembered that such a state lasts only for a comparatively small part of the year; indeed it is usually confined to the flush periods of growth in the latter part of the spring and earlier part of the autumn when the conditions of both moisture and temperature are ideal for rapid growth. Such understocking from May to September, however, with its concomitant selective grazing is ruining the botanical composition of pastures very rapidly and consistently.

It is in the nature of farming for conditions to vary, and each spring in turn the farmer will be faced with the difficulty of knowing the weather for the forthcoming season and hence what stock to carry. Nevertheless he should endeavour not to expose either his animals or his plants to adverse conditions if he desires to get the maximum return from them. Stunted animals and stunted plants give poor pay for their keep.

The next form of maltreatment of pastures, particularly in ' grass sheep ' areas, is overgrazing in the winter and early spring which makes the early grasses—our most valuable grasses—shorter lived than they need be.

With a little foresight and understanding of the principles controlling the growth of the various constituents of pastures and the competition between them, these two faults can be made complementary and both wiped out at the same time.

The area of grazing allocated to the stock during the flush growth in May should be reduced. The animals in most cases would thrive and be just as healthy on a reduced area at that time, whilst such a practice would serve to encourage the all-important Wild White Clover and obviate the existence of large areas of rough pasture that are usually left ungrazed for the rest of the year. The growth on the surplus area should be cut and conserved in the form of grass silage or dried grass for use during the following winter and early spring, when it would serve to feed at least a part of the flock and thus save the early grasses from being penalised at their critical stage every spring.

In addition such a cut taken in May would consist predominantly of leaf and would thus afford a ration well balanced as regards both protein and the carotene so necessary for vitamins. Both of these constituents are sadly lacking in the usual grass cut taken later between mid-June and mid-July for hay. Thus proper manipulation of the grazing would improve the quality of the crop removed from the land for winter consumption and at the same time improve the pasture itself for future use, by enabling the better species of plants not only to persist but also to dominate in it.

It has been pointed out that it is the good plants that usually suffer most where the animal has to eke out a bare living. It must also be remembered that these good plants withstand such periods of harsh treatment better if the remaining factors of their environment are favourable, *i.e.*, if the soil does not suffer from stagnant water through lack of drainage, from acidity through lack of lime, or from lack of the essential food constituents such as phosphates, potash and nitrogen.

Nitrogen can be supplied to the soil through the medium of clover, which fixes the nitrogen of the air by means of the nodules on its roots, but the other constituents—phosphates, potash and lime—must be added directly wherever the soil may be deficient. Phosphates are doubly important in that they not only supply the essential ingredient phosphorus, but also encourage very markedly the activity of clover in furnishing a natural supply of nitrogen to balance it.

When money is spent on manures, however, the necessary labour should be devoted to the grassland to enable proper use to be made of it. This labour should be applied mainly to the control of the grazing and the conservation of any surplus accruing during the flush periods as silage for use during the lean periods, particularly in order to give an adequate supply of green fodder during the winter. The amount of labour required would be only one-fifth of what would be needed to maintain the land under tillage, and the fodder thus produced would have a higher protein content than would a root crop.

NATURE, SCIENCE AND LABOUR IN AGRICULTURE

H. M. CONACHER

IF one were to ask what are the relative parts played by land and labour in agricultural production, as between them covering the ground, that might seem to ignore the other so-called factor recognised by the economists—capital. But suppose we try to bring it in, where is the line to be drawn between land and capital, for land is the capital of agriculture? Then there are live stock and tools and machinery—they are 'capital,' but they are capital of a different kind from land. Then again animal husbandry is not quite the same thing as pure agriculture and if other capital than land comes into the former, it does so not in the same way as in the latter. Again what about improved land, buildings, drains, lime and manure? If 'land' is something distinct from capital, which of the two are they?

It might be argued that these three 'factors' have been recognised in agriculture, because in this country there happen to be three parties in the industry—landlords, farmers and labourers—and when the economists warmed up to the work of distributing the returns, they assigned rent to the landlord for his land, profits to the farmer on his capital and wages to the labourer for his labour, ignoring the facts that the landlord has also sunk fixed capital in the farm, the farmer may take a hand with the work on the farm, and the horses also take part in the labour.

The distinction between the alleged roles of the landlord and farmer has in fact always been something of a fiction. The landowner necessarily has some say at least indirectly in the control of the enterprise. Prior to the grant of 'freedom of cropping' to the tenant farmer the landlord or his agents prescribed the course of farming in some detail; and even if they failed to do so in so many words the lay-out and equipment of the farm dictated the general notion of the enterprise. Again, if a farmer wanted some new structural improvements made to enable him to take up some new line of husbandry, he would have to satisfy the landlord of the probable success of the venture.

It is at the same time true that the various Agricultural Holdings Acts have placed the tenant farmer in as independent a position as a man making use of somebody else's fixed capital could well be.

Then again on what basis is the farmer's return alone called profits? If the landlord's rent goes up and down according to the rise or fall in prices of agricultural produce is not his 'share' also something in the nature of profits? The traditional way of 'distributing' the returns in fact treats the landlord's share rather as if it were a fixed charge, like interest on a debenture or a dividend on a preference share. If, however, agriculture as an industry has its own structure, there is little warrant for applying to it analogies derived from the modern and highly differentiated forms of joint-stock enterprise.

It is undoubtedly true that to make any comparison between agriculture or animal husbandry and other industry or commerce one must fix on somebody who is the entrepreneur, the party whose returns are called 'profits,' because it is he who also takes the risk of loss. And the entrepreneur is not always easy to distinguish in agriculture, where the enterprise often seems to be in commission and queer sorts of partnerships emerge.

Apart from this particular question, the question where 'profits' come in and who in particular gets them in agriculture may perhaps be shelved for the moment. 'Profit' anyhow is a rather indefinite term. It seems in its original use to apply most suitably to the gains of a merchant, because in the process of buying and selling there seems to be always a speculative element, which accounts for the recognised alternative of profit and loss. The rationalising economist, always on the look-out for mathematical quantities according to which he can represent these transactions, tends to minimise this speculative element and attributes as much as possible to the skill, expert knowledge and foresight of the buyer and seller—as if there were not always in the market deliberate speculators or the professional agents of such.

One can see a certain difference between the 'profits' of a merchant pure and simple and one carrying out a service, if the case be taken of a public works contractor or a manufacturer producing to an order and not for stock. For the contractor in making up his tender will estimate his 'profit' more or less in terms of interest on capital and earnings of management, so far as he follows the practice of accountants. The item for contingencies is strictly not to be regarded as an element in profits. It is true that in so far as he is tendering against competitors he is also in some respects like a merchant.

The position of the agricultural producer selling his produce has also been nearer to that of a merchant in recent years because unlike the manufacturer, who can go on short time or close his works for a time, he must go on selling, and that too in the post-war period at the mercy of constantly fluctuating prices, due to the perpetual disequilibrium between supply and demand. Hence it is idle to connect his 'profits' with cost of production and so incidentally to correlate them with his capital as a percentage thereof. Not but that there is something artificial about such a correlation, since in the case of a merchant it is turnover rather than capital to which profits are related, but the practice for what it is worth persists because it gives a rough measure of comparison between different kinds of industry.

For these reasons it is perhaps simpler, at least with a view to estimating the relative parts played by the factors of production, so far as distinguishable in agriculture (and animal husbandry), to limit the data of output to the actual returns rather than 'profits,' so far as this can be done. It will still be possible to make some estimate of the relative parts played by natural advantages and human labour and adaptation to environment respectively.

A well-known French 'agronome,' M. Zolla, in his book 'Modern Agriculture' points out that in agriculture there are three 'machines' directly at work—

the earth,
the plant,
the animal.

Each of them is a machine or agent of transformation. The earth or soil in virtue of the perpetual physical, chemical, and bacterial processes happening in it affords food for the plant. The plant absorbing food from the earth and working up the sun's light through chlorophyll builds up its tissues. The animal in turn grows and comes to maturity through the plants which it eats.

As regards these various activities the role of man is indirect, though directive. He can to a certain extent control the composition and functioning of the soil, put the plant in the proper milieu, set the animal to graze or feed it with more concentrated food, but in the end the issue passes largely out of his control. Hence the labour of cultivation may be thrown away.

This statement applies less of course to certain specialised forms of animal husbandry, as dairy farming, the keeping of pigs and poultry, and cattle-feeding, except so far as these include grazing on natural pasture. On the other hand neither stock-raising nor agriculture is exempt from loss caused by animal and plant diseases, which of course are quite distinct from the risk of damage by excessive heat and cold, drought and moisture. The feeding of stock on food other than natural grass does, however, illustrate a tendency by which the particular hazards of agriculture are reduced under forms of factory farming. In these forms the work of the farmer is something like that of a manufacturer buying his own material, cotton or wool or flax. The live stock are his machines, unlike other machines in their liability to disease.

In a more general way the hazards of agriculture are reduced by the survival of the cultivation of the staple plant products in regions with the more stable climates. One stresses climate, because apart from the direct effect of climatic excesses on growing crops, climate also influences soil, so much so that soil is determined very much by climate. This must be remembered, as there is a certain tendency to regard fertility of soil as paramount.

Yet there are certain plants of general consumption, which manifestly depend rather on climate than on soil for their suitable environment, as cotton, rice and the sugar cane.

Cotton is grown generally between latitude 40° North and 20° South (there is of course more land in the regions 30 degrees North than in those South of the equator); as a cultivated crop it is an annual and in the six months of its growing season it must have a steady high temperature, and a fair distribution of rainfall through the growing period. Rice again in its growing time must be screened from frosts, which is secured partly by growing it at the earlier stages in water.

The sugar cane is also a sub-tropical plant, and if recent experience has shown that the favourable natural conditions under which it is grown put the growers of sugar beet at a disadvantage, this is due to climate rather than to soil, for the soils on which the cane is grown are not markedly superior to those where the sugar beet is grown. Indeed in general tropical and sub-tropical soils are not so good as the black soils of the temperate regions. This again is a matter of climate; the high temperatures so hasten the decay of organic matter that the accumulation of humus is checked. It is of interest, however, to note that there may be some affinity between the black cotton soils of India and those of the southern part of the United States, where cotton is grown. In these there is more humus than in the red soils of tropical areas.

On the other hand, if one considers the great areas where cereals other than rice are grown (mostly in the temperate zones)—Southern Russia, the Danubian basin, the prairies of North America, the pampas of Argentina, and Southern Australia, in the case of all except perhaps Australia it is the fertility of the soil—all these great stretches of black earth—to which the grain crops would be attributed. Yet it is significant that most of them are grass lands, not forest lands, which indicate a lower degree of moisture. Indeed a great part of the world's crops of wheat and other cereals is grown on semi-arid land, where the climate is liable to bring droughts. They are in fact rather like the steppes, where the growth of spring vegetation is striking, but the plants do not last long. Hence there is always the risk of the grain being scorched before it ripens. This risk might be greater if the crops were spring-sown, but except in the Canadian prairies and Minnesota and the Dakotas, the wheat is universally winter wheat, as the winter conditions are not severe enough to kill the plants and so a longer growing period is ensured.

Further, the distribution of moisture over the year, combined with the alternatives of high and low temperatures in summer and winter, at once provides conditions under which the decay of the humus is retarded, and the upward and downward movements of water in the soil are so regulated that there is less of the leaching with loss of mineral constituents from the upper layers of the soil, which happens in humid soils.

The fertility of the black soils of the temperate zones is then largely the result of climatic influences, favourable to the soil, but not always favourable to the plant during the growing season, whereas in tropical and sub-tropical regions the conditions of climate are paramount for the growth of the principal commercial plants.

Taking all the world over there is a certain balance of forces, and if to these be added the human factors of labour and organisation in the wide sense it may be said that the agriculture and the animal husbandry of any region are determined by (A) soil, (B) climate, (C) labour and (D) organisation. In modern times C and D may so operate as to make good any defects in A and B.

Thus in contrast with the area and range of the cereals we may point to the potato and sugar beet, which are grown in the temperate zone on more humid soils than the black earth. Sugar beet is grown in the corn belt of the United States as well as in Europe. In a sense the cultivation of these roots or tubers is a great innovation on the natural order of things, for the cereals are but cultivated grasses and the pulses members of the wide-spread leguminous family. It is carried on upon the brown earths and the leached podsols, often quite sandy, as for example along the Baltic (at least so far as regards the potato). Hence no crops so generally grown owe more to human intervention, in the application of farmyard manure to maintain the humus and of fertilisers to ensure good yields. The north German soils in fact are largely of human creation.

The soils of the European countries indeed are largely artificial, the product of human cultivation. Much of the European plain in fact consists of brown soils, which in nature are less fertile than the black soils. Aeration and drainage are secured by human labour, the humus kept up by manures and the defective or lost mineral salts made good.

Europe of course is not the only continent in which an equilibrium has been struck as between the forces of nature and human activities of adaptation. The same thing has happened in China and India, in some of the more advanced American communities of the past and to a less degree among some African tribes. The agriculture of the European plain is a modern thing, barely 150 years old, and it does represent an achievement of man in modifying the soil by chemistry and regulation of the supply of moisture. It was in the latter sphere, *i.e.*, in irrigation, that human intervention on the grand scale had been eminent outside the European plain.

The next great move—the settlement and cultivation of the great areas of black soil in Russia, North and South America was like a return to nature, in which man at first did little more than go through the ritual of seed-time and harvest. Now more recently we have seen the great expansion of sub-tropical and tropical agriculture, in which human initiative has had to play a great part and the need of applied science has been freely recognised. It looks then as if there were a sort of rhythm, in which the forces of nature and human art and science alternated.

Returning to Zolla's analogy of the machines, we may say that in modern Europe earlier forms of human intervention affected the composition of the soil itself, by the work of the chemists, who showed what was wanted as plant food, what was taken out by different crops, and how losses could be made good. More recently, however, it is the plant that has been modified so as to increase its efficiency or adaptability. It is on the whole upon the lines of selecting plants endowed with the faculty of resisting the disadvantages of climate, such as were noted as going with the more fertile soils, that the greatest advance towards an increase of agricultural production has been made in recent times. This movement in its way is as important as the discovery of artificial manures, or the great improvements in breeds of live stock of an earlier age.

The cereals have been the main subjects of plant-breeding, and the features of endurance of drought, early ripening to escape autumn frosts, and resistance to certain diseases have engaged the attention of plant-breeders in the case of wheat and other grains.

The breeding of improved strains of animals on the other hand was directed towards increasing either the all-round ' efficiency ' of the animal, or some particular feature such as better milk production in a dairy herd, better wool in a sheep, higher laying powers in a hen, or the distribution of flesh about the skeleton in such a way as to secure a supply of good bacon in a pig. On the whole the object was not to adapt the animal to life in this or that environment, which indeed is more or less artificial in the case of many branches of animal husbandry.

No soils new or old will yield crops for long, unless they are dealt with according to the rules of good husbandry. The Russian peasants, cultivating nominally on the three-field system, exhausted the land by turning meadow land into arable, reducing live stock and so curtailing farmyard manure. The Spanish farmers with their dry farming keep production at a low level, by not growing forage crops and so obtaining manure.

So too in the States west of the Mississippi the soils were able to bear crops in spite of small winter rainfall and summer drought, because they were ' deep, fine-grained, and uniform.' Then too the humus has a good deal to do with storing the moisture in the soil. The farmers do not seem to have been alive to the need of preserving the texture of the soil—apart from any questions of the loss of plant food by fairly continuous cropping with grains. Even before the war the United States authorities recognised that American agriculture had passed its pioneer stage, and that no longer was it enough simply to rely on the natural fertility of the soil helped out by tillage. Concentration on a single type of crop was a mark of the passive forms of agriculture. They singled out two regions where this was showing bad results, the South Atlantic States and the States west of the Mississippi. The soils of the former were familiarly described as ' worn out ' in spite of the liberal application of commercial fertilisers in the period after the (Civil) war. The coming of the boll weevil, however, had hastened a more diversified practice. As a report said (1912) ' fertilisers have been used more intelligently; the adaptation of crops to types of soil has been considered, rotations introduced, better tillage employed, it is rapidly becoming evident that the " worn out " soils of the South, under intelligent management, compare favourably with those of any section.'

More recently of course the cotton area has had fresh troubles, partly due to the low efficiency of the planter-share-cropper system, and the cotton belt is moving further west.

In the States west of the Mississippi it was found that partly owing to their rapid settlement simple forms of agriculture had persisted, crop rotations were unusual, and fertilisers were seldom or never employed. Though soils were falling off in their yields, farmers did not like to use fertilisers, fearing that this might advertise the fact. The demand for grain in the Great War masked all this, but the results of letting down the humus content of the soil have become only too apparent in recent years.

In Canada and Australia, where it was the practice at one time to cut off the ears, leave the straw standing and thereafter plough it into the ground, some of the organic residues were restored to the soil.

Such undermining of natural fertility in new countries is of course different from the persistent encroachment of arable cultivation in Italy and Spain on forest land (often on hill slopes) which tends in time to soil erosion. Something of this kind apparently also happens through the primitive agriculture of central African tribes.

In this country we are much aware of the great new areas used for grain-growing in America and Australia and of the beef production of Argentina, because our own farmers' interests are affected. For the purpose of this argument, however, one cannot ignore the great extension of tropical and sub-tropical agriculture in recent years.

It is distinguished from the agriculture of the temperate regions by the much greater part assigned to tree crops, not for timber but for their fruits. Not but that certain cereals, as rice, maize and sorghum, have also long been grown in these regions. Tobacco and cotton too are field crops and the tea plant is a shrub. The cereals are grown mainly by the farmer population of the countries where they are grown and consumed. There is usually a long tradition of agricultural practice behind the growing of these crops. Thus rice seems originally to have been a swamp plant. Hence far back Asiatic rice growers learned to grow it in its early stages in flooded fields. The tree crops, however, are largely planters' crops; at the same time in Jamaica and other West Indian islands the peasant has his share of such enterprises and in the far East Indies the native planter of rubber was able to bring to naught the Stevenson and other restriction schemes.

The climate of these regions also is usually not continental, like that of the great grain-growing zones, but more affected by the sea, South Australia, South Africa and California having a climate like that of the historic original of such types of cultivation (the Mediterranean lands), and India and the East Indian Islands monsoon climate. Perhaps one might take the lands round the Gulf of Mexico and Caribbean Sea, including the West Indies, as the American equivalent of the Mediterranean region.

In the Mediterranean region the olive and vine have been cultivated for centuries; it is here too 'wo die Citronen bluhen.' The tropical and sub-tropical cereals are grown mainly for local consumption, and except maize which came from America, have long been grown by their consumers. The tree crops, however, have in many cases been introduced by Europeans or Americans and are grown by 'capitalist' planters. The cereals of course are annuals and can be adjusted to drought conditions, and among the trees the olive has made its own adjustment by producing leaves which check transpiration. As has been noted however, the fruit-tree producing areas have usually rainy seasons, which mitigate the tendency to drought conditions. What is further noteworthy is that many of these plants, producing tea, coffee, cocoa, sugar cane, citrus fruits, tobacco, cotton and bananas require good soils. Most of the fruit trees do not like sandy soils or heavy clays. As many of these regions are insular or maritime, it happens that a considerable amount of volcanic rock goes to form the soil. As the fruit-bearing trees have deep roots, it is an essential condition that they should grow in soils of a fair depth above the water table.

There are various points of difference between agriculture in tropical and in temperate zones. The greater evaporation of the former makes a higher rainfall necessary to give the equivalent amount of moisture. On the other hand the indication of the breaking down of humus in the tropics may be exaggerated. Certain chemical states also, as those of acid and alkaline reactions, may give different indications in tropical regions.

Tobacco and sugar cane and to a less extent cotton make serious demands on the main plant foods. The tree crops are much in the same position. The growth of leguminous crops to be ploughed in has become the great stand-by in planter agriculture for securing fruit trees a due supply of nitrogen. Again, though the fruit may be formed largely through the action of the sun's light and heat, the tree may want plant food for its own purposes.

All this goes to show that though Chinese and Indians may have achieved a settled practice in the cultivation of their staple foods through centuries of experience, plantation agriculture by the 'white man' has still a good deal of trial and error before it. Indeed it means a careful selection of soil and climate, husbanding of water supplies, considerable capital outlay, and general skill and foresight. Even 'cheap' labour may be a snare, just as slave labour made the old plantation agriculture of the slave States inefficient. Hence one cannot say that it is a case of merely drawing a 'rent' from advantages of soil and climate.

Perhaps something should also be said of the pastoral industry, as primarily dependent on nature for good grazing land. Here the relative spheres of nature, capital and labour are well marked, for capital takes the form of the live stock, labour is employed in herding and tending the flocks and herds. The land is less in the nature of capital for the cultivator, his interest in it is more superficial, as witness the fact that he is often less of an owner and more of a mere user.

It was noted earlier that the grain lands of the present time were originally grass lands, many of them of steppe character, *i.e.*, tending to be droughty towards summer. Hence so far as nature is concerned pastoral husbandry tends to be seasonal and nomadic. In a community which as a whole is settled, this nomadism only affects the shepherds. The change of pastures is called 'transumacion'—to pick out the Spanish form, as the great movement of sheep from the Pyrenees to Estremadura is the most notable instance of this process in Europe. It also happens as between the Alps on the one hand and the delta of the Rhone and North Italy on the other. For cattle the former movement from Texas to the corn-growing belt of the United States was well known. Apart from actual herding the chief function of the pastoralist has been to find natural pasture all the year round or otherwise to provide feeding-stuffs. In such a droughty country as Australia too the digging of artesian wells is also his job.

So soon as animal husbandry becomes in any sense intensive the pastoralist has to become to some extent a grower of crops. This is worth insisting on. It is often suggested that the beef producers of this country, as competing with those of the whole 'Plate river' region, are handicapped by the great natural grazing resources of the latter, whereas in reality they are handicapped by the fact that the South American owners of estancias are operating both on a large scale and in a specialised fashion. They have of course the advantage derived from the available quantity of land in a big new country, as distinct from quality. But their success is largely due to their production of alfalfa on a large scale as a forage crop. If nature helps them, it is perhaps not least in providing a climate and soil for the growth of alfalfa. It is curious by the way that the leguminous plants, having played a great part earlier in giving man the pulses as foods, are now returning as forage crops.

Natural grass as a stand-by, even for three-fourths of the year, is a rare thing anywhere in the world. In mountainous regions such as the Alps the winter comes to close things down. Hence one has to look to marine countries in temperate zones for grass, and if they are islands, so much the better. The British Isles and New Zealand accordingly emerge among the first, and it is to be noted that in both cases the grass is coming more and more to be the basis of an intensive form of animal husbandry—dairying.

The great role of man in modern times, as agriculturist, has thus been in the improvement of soil, plant and animal, and that not least with a view to making good natural defects in all three and adjusting their association. It would hardly be accurate to describe this simply as adding to the part of 'capital' in agriculture, except perhaps in the case of live stock. The new variety of wheat called Marquis soon found its way into all the farms of the prairie provinces of Canada. The increased power of man has in fact come from science. All this has, however, emphasised the function of man as entrepreneur and depressed that of labour. That still leaves even with the peasant his traditional skill and the knowledge of his own land.

If traditional knowledge is the mark of an old rural economy, equally one must do justice to the pioneer efforts of settlers in a new country. The fertility of the grain-growing regions of North America was only a potentiality until human labour was applied to the soil. Hence if the normal operations of husbandry are dismissed as a mere routine, those who are inclined to attribute everything to the richness of virgin soil forget that a whole community had to form itself in order to reap the harvest. In the United States and Canada, the State, in deciding to develop the prairie regions through the plan of the Homestead Law, was acting as the supreme entrepreneur, but under that plan a great number of working farmers were invited also to become entrepreneurs on a small scale. So they had to break up the land, discover its secrets, devise suitable systems of husbandry, equip their holdings, and build up a corporate life, as far as might be, through communal services. The provision of railroads was left to other agencies. Hence if one is to compare the economic condition of the 'middle west' farmer with that of a farmer in an old European country, as a set-off to the advantages of virgin soil one would have to credit the former with a number of responsibilities, where the latter takes everything for granted. If the systems of agriculture are compared, it comes to measuring one in which say 15 bushels of grain to the acre are gained, subject to a fallow but little outlay on manures, and with all the work overtaken in little more than half a year, against another which returns 30 bushels to the acre with full use of fertilisers, little fallow and work spread over the year.

One emphasises such things as the traditional skill of peasants in Europe and Asia, the pioneer work of North American farmers, because the existence of the small entrepreneur over so much of the earth's surface makes it difficult to draw the line at which pure labour ends, and the technique of the entrepreneur begins.

Labour, however, in the analysis can be identified with the familiar and characteristic operations of husbandry, 'cultivation' of the soil in the wide sense, sowing, harvesting (including picking of fruit), threshing, and the herding of flocks and herds. As compared even with other primitive occupations, such as fishing and mining, the operations of husbandry are on the whole slow and laborious and less effective. In fact if they are judged by the standards of any other industry, they would be accounted for solely as offering the only conditions on which the labourer obtained direct subsistence as the fruit of his work. This close connection underlies the persistence of all such arrangements as give the landless labourer a share in the actual product as his remuneration, when he is working on the land of another, or of 'letting' him land even for a season and allowing him to take the returns, or again of paying him partly in kind.

In some simple communities working 'on their own' agriculture for exchange begins when there is a surplus, after subsistence has been attained, and merchants offer to buy it.

If the soil, animal, and plant are regarded as independent agents, it follows that the labours of cultivation and the care of animals are the most effective, as assuring the good working of the 'machines.' Even in cultivation, however, the business of manuring calls for decision on the part of the farmer, which is more important than the mere act of spreading manure or fertiliser.

Machinery has been introduced to make good the shortcomings of manual labour or to get round the scarcity of it. Thus ploughing, harrowing, sowing and spreading are helped out by machinery partly because the sheer extent of ground as well as the texture of the soil make them slow for manual labour, while harvesting is also done by machine to quicken the process and combine two or three stages in one. The more machinery is introduced, however, the more the return to labour will go to the entrepreneur as owner of machinery. At the same time the machine-using worker will have his efficiency increased, and he will require greater skill, just as does the horseman at an earlier stage.

The increase of mechanisation has tended to throw farm work into a series of isolated temporary jobs, while increasing the efficiency of the worker. Again it has led to an increase in the size of farms, as in the Canadian Prairie provinces, where the average size of farm is now between 300 and 400 acres. In fact it has done more to introduce 'capitalist' farming than the use of fertilisers, or improved strains of plants and animals. Improvements in these directions have in fact been stimulated by research and in the case of live stock by actual aid to small farmers to get the services of better sires, all conducted or encouraged by governments out of public funds, so that the benefits have spread to the farming community at large.

The ascertainment of the return attributable to the several factors in production does not settle its distribution. In the case of agriculture for subsistence it will go to the groups of producers. Where it is for exchange the returns according to the realised value will go primarily to the entrepreneur, who has control of soil, plant and animal, and takes the risks of the enterprise. The identity of the entrepreneur varies under different systems. In the case of the European and Asiatic peasant proprietor and the occupying owner of the United States and the British Dominions the actual farmer is the entrepreneur, and in the majority of these groups his return will be derived from land and labour (land covering the natural resources of soil and climate), seeing that capital apart from land here is insignificant.

The labour, however, on the whole is skilled labour, as not least conspicuously in the case of the Chinese peasants, who have carried to a high art the preparation of a compost 'ready to use' for the land, as well as the flooding of rice fields. Further, in the case of the European peasant it is interesting to note that on a fairly small holding a series and variety of operations is designed so as to keep the labour power always in use.

The European and American planter exploiting a plantation in tropical and sub-tropical countries is the sole entrepreneur. In so far as the returns come from tree crops and not from field crops, the trees or bushes are, apart from the land, a substantial part of his capital, as are any irrigation works that may be needed. The native labourer gets a share of the return on terms fixed generally by the planter, who pays for the labour at rates determined mainly by the low cost of living at native standards of tropical and subtropical regions. This goes along with the advantages in climate and soil as justifying expectations of profit. The outlay on fertilisers and the scientific knowledge applied to the enterprise are part of the planter's capital. There is of course also an element of goodwill in his assets.

The case of pastoralists and ranchers is peculiar. In modern times they are entrepreneurs who have got a concession of grazing land in new, unsettled country of ' colonial ' type, but now in touch with the civilised world through modern communications. It is true that the area of the concession may be very large, even if there is little keep to the acre, but the great area may mean more careful herding, or well-trained stock, but probably not extensive fencing. In Australia, however, a permanent improvement is indispensable in the shape of artesian wells. Even so a drought may starve great flocks. Perhaps the fact that cattle and sheep are ruminants is almost the basis of this form of enterprise. Second to this in the case of sheep is that they yield an annual crop of wool, which though bulky is not difficult to transport.

Cattle-grazing on ranches was once a great industry in part of the United States. They were reared on the Texas and certain other ranges west of the Mississippi and then taken to the corn belt to be fattened, but that is now a thing of the past. In Argentina too the estancia industry has changed. The pampas region which grew grass will also grow grain, so that a good deal of the earlier pastoral land is now arable. And the owners of the estancias have taken to growing the forage crop of alfalfa, so that they may now be regarded as scientific beef producers, and their returns are a reward of a sound technique following that of the earlier invention of the frigorificos.

In many varieties of tenure, both landlord and tenant have some claim to be regarded as entrepreneurs. Even in the normal British form of tenancy it is impossible to exclude the landlord from a share of the enterprise, if on no other ground than that his rent varies according to its success. Indeed, even if the farmer is free to carry out the details of the undertaking, it is the landlord's capital of improved land that makes possible and indeed determines the general type of enterprise. The further we go from this British form of arrangement down through the métayage of France, central Italy and Spain, to the share cropper of the Southern States, the greater is the share and the more commanding the position of the landowner, so that there is a sort of partnership of capital and labour in which the labourer is paid on a different method from that followed in wage-earning industry. This is not paradoxical, because in agriculture the labourer is always tending to acquire a skill and knowledge of production, which goes beyond the mere carrying out of the routine operations of his craft—for he is a craftsman.

CERTAIN BOTANICAL ASPECTS OF THE DYING-OUT OF HEATHER

(*Calluna vulgaris*, Hull.)

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Two of the most important problems which face the hill farmer are the invasion of his grazing area by bracken and the curtailment of his winter keep by the dying-out of heather. These two troubles are not unconnected. The annual increase of bracken is largely at the expense of the heather, and the more the heather decreases the greater is the toll taken upon the remainder by its pests, for unlike bracken it has various insect and fungoid enemies. Moreover, continuous grazing by sheep, which select the more palatable and better grasses, has progressively thinned these out and so prevented rejuvenation by seedlings. To a more limited extent this has also occurred with heather. It has been demonstrated at Garelochhead that bare areas which have been enclosed by wire netting can produce good crops of heather (15-18 inches high in 6 years), and that this volunteer growth completely suppressed the sown grasses in a year or two, but the adjacent unenclosed areas have produced few heather plants, for the hares and sheep have sought for them too successfully. Grazing obviously assists in keeping heather in check. That is why burned areas should not be too small; otherwise they are too severely punished in the subsequent grazing.

From a botanical point of view, the increase of bracken and the decrease of heather are most suggestive. Both problems are connected with the exploitation of the hill land during the past 150 years, and it is more than likely that when we learn how to arrange the factors so as to inhibit the bracken naturally we shall at the same time benefit the heather. The investigation is, however, an enormous one.

One of us has been interested in the subject for the past decade and has examined countless areas of heather in the search for fungous parasites. Until last summer none was found that appeared to be general and to be associated with relatively fresh leaves and stems. It was therefore accepted that the heather beetle was to blame for the major damage. Last August, however, Mr Charles M. Collins of Rowardennan, Loch Lomondside, forwarded a specimen to the West of Scotland Agricultural College, Glasgow, consisting of a piece of dying heather attached to which there was a piece of rhizomorph—a perennating thread of fungal tissue produced by certain fungi, comparable to the runner in strawberries. Subsequently Mr Laird, County Organiser for Ayrshire, submitted a sample of diseased heather containing a similar rhizomorph. In neither of these cases was beetle damage noticeable. A systematic search then showed the rhizomorph on dying heather at Callander and Milngavie and in Renfrewshire. A visit was paid to Rowardennan in mid-September, under the guidance of the head keeper, Mr Kennedy, to areas which had been quite brown a month previously. It was evident that the trouble had been a severe attack of heather beetle, but the fact that in the month the plants had produced shoots from ¼ inch to ¾ inch long showed that the beetle attack had merely pruned and not killed the plants. It is therefore most certain that severe attacks by the heather beetle itself need not kill the heather. In this heather there was little sign of the rhizomorph (one piece was seen in 30 minutes); the heather was young, short and healthy.

A botanist would not expect the ravages of heather beetle to kill the plant unless the bulk of the plant was deprived of its leaves. Probably the chief trouble is that it wounds the plants and so allows the entry of a parasitic organism. It is still more probable that it is the more unhealthy heather on the most unsuitable sites that suffers most from both insects and fungi. Egg-laying beetles choose sphagnum moss, so the initial broods start in such situations, not on the most healthy heather.

Enemies of Heather.—What are the enemies that attack heather?

1. *Heather Beetle.*—Since 1934 considerable alarm has been caused to owners of grouse moors in Scotland and others interested in the maintenance of good stands of heather, by a dying-off of heather. It has been known for some time that the heather beetle (*Lochmæa suturalis* Thomson) could cause severe damage to heather, and the density of the beetle population during the last four years has led to the conclusion that an epidemic of heather beetle was responsible for the disease. This view coincided with the opinions expressed in Germany in 1930 (4) to account for a disease of heather assigned previously to an attack by the fungus *Stemphyllium ericictonum* (2) or else to the extremely severe winter of 1928-29. The heather beetle has been recently fully dealt with by Dr A. E. Cameron (3), and fortunately is being further investigated.

2. *Scale Insects.*—These appear to be very general and one of the most common is an insignificant one on the stems which Dr A. E. Cameron has identified as *Lepidosaphis ulmi*. It is quite capable of producing wounds that could be invaded by other organisms. Another, which has not yet been identified with certainty, is a white, woolly creature common in the autumn.

3. *Stemphyllium ericictonum* (2) is a fungus with no common name, which was recorded as being parasitic, but is a doubtful record as it has since been disproved.

4. *Corticium sp.* has been recorded by Betrem in Holland and has been cited by Cameron (3).

5. *Phytophthora cinnamoni* in pot plants has been noted at Cheshunt (6).

6. *Dasyscypha nivea* was found at Knoweside, Maybole, in 1929 and has been seen practically everywhere since in the autumn on dead and dying heather. As *Dasyscypha willkommii* is the well-known cause of the Larch disease, *D. nivea* has been carefully watched, but it is nearly always associated with the old senile heather and there is no proof that it is an active parasite.

7. *Rhizomorph fungus.*—This consists of a black horse-hair-like thread, which is found in association with dead and living parts of heather. At first this was regarded as being a diminutive rhizomorph of the deadly *Armillaria mellea* which is such an important tree disease. It had been recorded from Scotland (1) and from Belgium (5), but when sections of the thread were made, it was obvious that it was of quite another type. It is not possible to assign the rhizomorph with any degree of certainty to a named fungus, but the internal structure was compared with a fragment of the rhizomorph of *Marasmius equicrinis* Müll.—the horse-hair blight of cocoa—kindly supplied by Miss K. Sampson, Agricultural Botany Department, University College of Wales, Aberystwyth, who suggested the possible affinity. The latter was old and dry, but the general similarity is very striking—two to three cells of thick-walled 'cortex' spirally arranged and a large thin-walled 'medulla.' It is often branched. It has only been observed on one host other than *Calluna*, namely, *Erica tetralix*, which is also subject to a dying-off disease. Comparison of the threads from heather with specimens of *Marasmius androsaceus* (Linn.) Fr. preserved in the herbarium of the Royal Botanic Garden, Edinburgh, showed a close similarity. Miss E. M. Wakefield, of the Royal Botanic Gardens, Kew, has informed us that there is one specimen from heather labelled *M. androsaceus* amongst Crossland's Yorkshire fungi. This specimen has a small amount of the black mycelium attached. We have not observed any fructifications of *M. androsaceus* on heather and it is likely that the specimens are infrequent. The scarcity in mycological literature of records of this species on heather makes it appear that the perfect stage of this fungus is of rare occurrence. Comparison of cultures from the rhizomorph and the perfect form will be necessary before organic connection between the stages can be proved.

Description of Dying-off Heather.—Areas of recently diseased heather stand out clearly among healthy plants as fox-red in colour. Such fox-red plants have been known commonly as frosted heather, and the opinion of those associated with heather moors is that these plants have been killed by frost. Very frequently, however, diseased plants bear a rhizomorph growing out from the leafy shoots or from the stem at a leaf-scar. The fox-red plants later turn grey and by then many of the leaves have been lost. Dr A. E. Cameron, Advisory Entomologist to the Edinburgh and East of Scotland College of Agriculture, has distinguished three types of abnormal heather, the reddish-brown or purple form being nothing more nor less than the seasonal variant of the healthy heather. The other two types are definitely disease forms. The silver-grey heather not only occurs in old stands but may succeed the fox-red colour in injured plants. It is of importance to distinguish between the fox-red colour due to beetle attack and that caused by any other factors. Plants recently injured by beetle are fox-red in colour; they have lost many of their leaves and the distinctive colouring is mainly due to the stem. On the other hand plants bearing the rhizomorph and not injured by beetle may also be fox-red, but in this case the colour is due as much to the discoloured leaves as to the stem. Irrespective of the cause of injury, unhealthy heather turns red. In the autumn of 1936, Dr Cameron submitted to one of us (I.W.T.) some specimens of fox-red heather which he had received. The plants showed little or no sign of beetle injury and resembled the so-called frosted heather. Sections of the stems, however, showed abundant fungus hyphæ. Naturally healthy stems always have present the mycelium of the mycorrhizal fungus associated with heather so that the presence of hyphæ in the stems does not necessarily signify a pathologic condition. Cultures of stems gave rise to fungi in all cases, but various distinct types were obtained, presumably owing to the heather having been dead for some time and invaded by saprophytic fungi.

Ultimately heather attacked by beetle or injured from other causes will turn grey and at this stage it is almost impossible to state the initial cause of injury.

The Rhizomorph.—The black hairs arise from leafy twigs or from the basal stem. They grow out from the base of the leaf or from a leaf-scar and arise from hyphæ which mass together to give the thread. The rhizomorph resembles a horse-hair. It may be of varying length, frequently less than half an inch, but sometimes extending to three inches. A characteristic feature of the larger rhizomorphs is the branching. The branches, which may be an inch or more in length, arise at about right angles to the parent thread. The hairs when quite young are almost colourless and may be associated with green leaves. In this stage they wither very rapidly and are difficult to transport alive to the laboratory.

The hairs are found most frequently in the dead discarded twigs which have accumulated below the heather plant, especially if the heather is old. Many of these rhizomorphs are also dead. Examination of such debris lying beneath heather twenty to thirty years old very frequently shows the hairs arising from dead twigs. Such infected twigs do not of necessity come from a dead or dying heather clump; they have been found beneath healthy plants. In fox-red and grey plants rhizomorphs have been found both on the twigs and on the stems. Plants that have suffered an obvious beetle attack may carry rhizomorphs. Frequently twigs that are partly discoloured (that is with some leaves fox-red, but a few remaining green) show the rhizomorph, which usually arises from the base of one of the dead leaves.

During visits to moors it has frequently happened that the rhizomorph could be found only with difficulty, and it appears that certain weather and soil conditions are of importance in governing not only the regional distribution of the rhizomorph but also the distribution of the rhizomorph itself on diseased heather. This was very noticeable on one Argyllshire moor where an extended examination of the twigs of very badly diseased plants yielded negative results. But examination of one of these plants close to the soil level disclosed the hairs arising from the stem and entwining it, stretching downwards into the sphagnum and upwards to the first branches of the plant. Although rhizomorphs were abundant, they were not observed in that area on the twigs. On other occasions the rhizomorphs have been found only on the twigs and never extending towards the basal stem. At another time when rhizomorphs were abundant in the east of Scotland, they appeared to be rare in the west, although they re-appeared there after a few weeks.

It is considered that where the air is moist, rhizomorphs tend to develop on the twigs. Under drier atmospheric conditions, but where the plants are old and sphagnum has been able to accumulate beneath them, one may expect to find the rhizomorphs twined around the basal part of the stem. In the case of young heather, it is significant that, so far as the authors have observed, the rhizomorph occurs only on the aerial shoots and has not been observed on the basal parts of the stems. This distribution again is probably associated with a moisture requirement, for sphagnum does not accumulate until heather is at least ten years old and in many cases it requires fifteen years or more for the accumulation of a bed of sphagnum beneath the plants.

Diseased heather plants on which the rhizomorphs were growing have been found in Wigtownshire, Argyllshire, Perthshire, Skye, and Inverness-shire, as well as in many areas in the Lothians and in the areas near Glasgow which have been mentioned earlier in this paper.

Experimental Work.—In addition to observational work in the country, work was also carried out at the East of Scotland College of Agriculture on the power of infection of the rhizomorph and on the effects of frost.

A series of experiments set up to determine the role of the rhizomorph as an infective agent gave entirely negative results. A number of young heather plants were potted. Despite care in handling a few plants died at rather infrequent intervals after potting and infection experiments were not begun until the plants has been in pots for at least two weeks. Five healthy plants were infected by entwining a piece of rhizomorph around a young shoot. Another five plants were injured by cutting away the tips of leaves, while the stems of a third series of five plants were cut and a portion of the bark removed. Pieces of the rhizomorph were placed in contact with the cut surfaces. All the plants after infection were placed in a moist chamber for twenty-four hours. Control plants treated in the manner outlined above, but not infected, were observed.

Of the infected plants only one died showing the fox-red symptoms. This plant was one of the uninjured series. None of the remaining plants, either in the uninjured or in the wounded series, showed any signs of attack by the rhizomorph. It must be assumed that the death of the plant in the uninjured infected series was due not to attack by the rhizomorph but to some unknown cause. All of the control plants remained healthy. No evidence can be presented to show that the rhizomorph can attack healthy heather or that it can attack heather injured by wounding. One can conclude, if there is any relationship between the rhizomorph and dead heather, as appears to be the case from field observations, that the fungus is a weak parasite attacking heather which is unhealthy on account of beetle attack or some undetermined edaphic factor. It is also possible that the rhizomorphs used were too old and it may be that only the young hyaline stage can cause infection.

By allowing adult heather beetles to feed on heather plants in the green-house, it was possible to obtain a fox-red colour identical with the symptoms of beetle-infested plants in the field. By placing the rhizomorph on twigs of healthy heather and then allowing the beetles to feed on the plants it was thought that indications might be obtained of possible combined action of the beetles and the rhizomorph.

Two groups of four heather plants were infested with heather beetle and strands of rhizomorph were entwined about the twigs of one group. The resultant appearance of the plants in both groups after four weeks was similar, a general stripping of the leaves from the twigs and the development of a fox-red colour in the plants. The presence of the rhizomorphs did not accelerate the appearance of the red colour and it could not be determined in the time available whether the fungus could kill the plants after the beetle attack.

It is not considered from the evidence we possess that this fungus is a primary parasite, but its widespread distribution on dying and dead heather suggests some association with the present dying-off of heather.

Frosted Heather.—By many people the fox-red colour that develops on heather is attributed to the action of frost. Patches of fox-red heather stated to have suffered frost damage were seen in April and May of this year. Such areas sometimes coincided with the former location of a snow-bank, and it was suggested that the action of a strong sun on the snow would cause such a rapid thaw that the heather would be damaged. It is only in May and June that heather in the Central Uplands of Scotland begins to put forth young shoots. Previous to this time the leaves of the preceding year retain their reddish-brown colour characteristic of dormant heather. It is quite conceivable that the young soft shoots are susceptible to frost injury, but it is likely that mature twigs have acquired a certain tolerance to cold. Much of the damage in early spring is not due to frost alone, but frost and exposure to strong winds and sun may help some other factor to kill the plants.

Experimentally it has not been possible to reproduce frost injury under laboratory conditions. In one experiment four plants which had produced their spring growth of twigs were placed in a refrigeration chamber at a temperature of 26° F. The twigs of four more plants were sprayed with water so that droplets of water hung from many of the leaves. These plants were placed in the refrigeration chamber. After twenty-four hours all the plants were removed and placed in a green-house. For at least the first four hours after removal from the refrigerator, the plants were exposed to a bright sun, the green-house temperature being about 90° F. None of the plants showed signs of frost injury comparable to that observed in the field, and the only damage observed was a slight browning of the tips of some of the leaves. Despite the severe treatment of four of the plants, which on removal from the refrigeration chamber had their twigs partly covered with ice and were then exposed to a bright sun and high temperature, there was no significant difference between any of the plants.

It is important to realise that the plants used in the tests had been kept in a green-house in a moist condition for a few weeks before being subjected to freezing. It may be assumed that the twigs were softer and more susceptible to frost than those of plants grown in the open. The experiment is open to the criticism that the temperature to which the plants were subjected was not sufficiently low in comparison with the intensity of frost likely to be experienced in the field. While it is true that no very low temperature was tried, the condition of the plants grown in a moist warm atmosphere, with the consequent development of tender shoots, made them very susceptible to frost. The formation of ice on such succulent shoots and the very rapid thawing at a high temperature would give a test as severe as would be found in the field.

It is more likely that a strong drying wind in bright sunlight might produce a fox-red colour in the shoots, but lack of facilities prevented any experiment on these lines being attempted. Low temperatures alone do not cause the fox-red colour to appear, but other factors—strong wind and sun and possibly fungus attack—may be of importance.

Discussion.—The wide publicity given to the heather beetle by sporting journals and other papers has in our opinion tended to exaggerate its status, and has led to a neglect of other possible factors that may influence the health of heather. The heather beetle is certainly of great importance and during some years, as in the last three, can be recognised as the major influence at work. One can frequently, however, see heather plants, fox-red in colour and presumably dying, which show no sign of beetle attack. It is unwise to consider frost the agent next in importance to the heather beetle without either experimental proof or accurate continuous observation on selected areas exposed to severe frosts. Consideration should rather be given, if it may be assumed that some other factor or factors than the heather beetle are at work, to a study of the environmental conditions which give rise in the first place to epidemics of the heather beetle and secondly to the agents responsible for heather degeneration in the absence of insect attack. It is very possible that the environmental conditions which lead to great increases in the population of the heather beetle may also stimulate other agents such as fungi to attack the heather.

First in importance in any investigation of the dying-off of heather is the elucidation of the conditions that control the life of the plant. It is unlikely that any adequate control of this heather disease can be obtained until we have fuller knowledge of the weather and soil conditions important to heather. Whatever investigations may be considered in the future on this problem one line of research must be carefully followed. A knowledge of the ecology of the heather plant is essential, for it is only by an understanding of the conditions involved in the growth of heather that any advance in the methods of control of its parasites can be made. Indeed it is very likely that the conditions which lead to an unhealthy state of the heather may at the same time stimulate the parasites to greater activity.

We wish in conclusion to offer our warmest thanks to the persons mentioned in this paper for their ready assistance, and especially to Dr A. E. Cameron of the University of Edinburgh.

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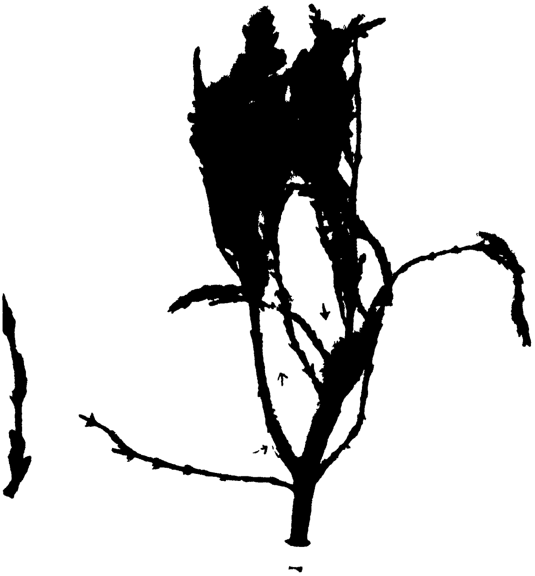

FIG. 1. Branch of fox-red heather with black hair-like rhizomorphs attached to the twigs. Arrows indicate the position of the threads. Three-fourths of natural size.

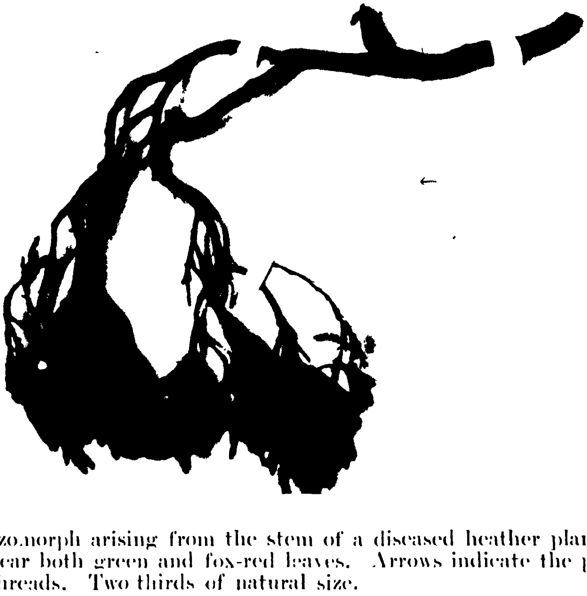

FIG. 2. Rhizomorph arising from the stem of a diseased heather plant. The twigs bear both green and fox-red leaves. Arrows indicate the position of the threads. Two thirds of natural size.

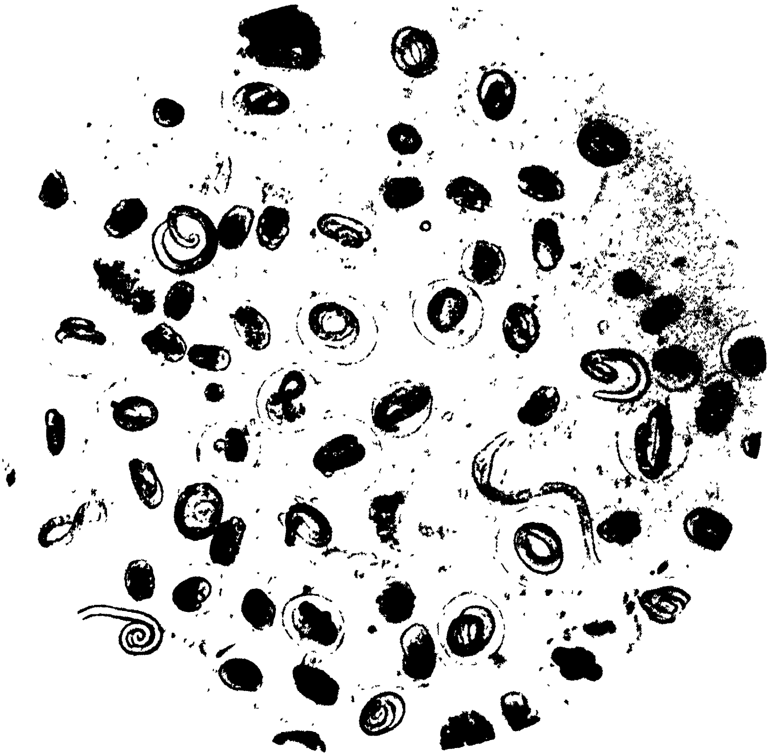

PLATE I

Photomicrograph of lungworm eggs at various stages of development, and larvæ at first stage. Magnified 65 times.

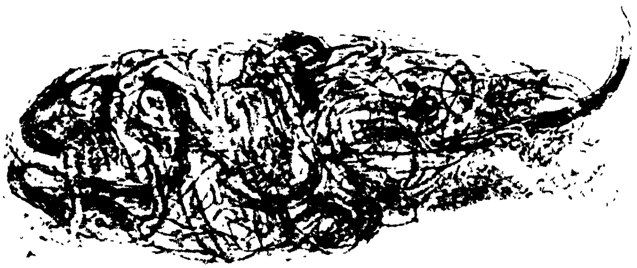

PLATE II

"Heart" of an earthworm well packed with infective larvæ of the common lungworm of the pig (*Metastrongylus elongatus*).

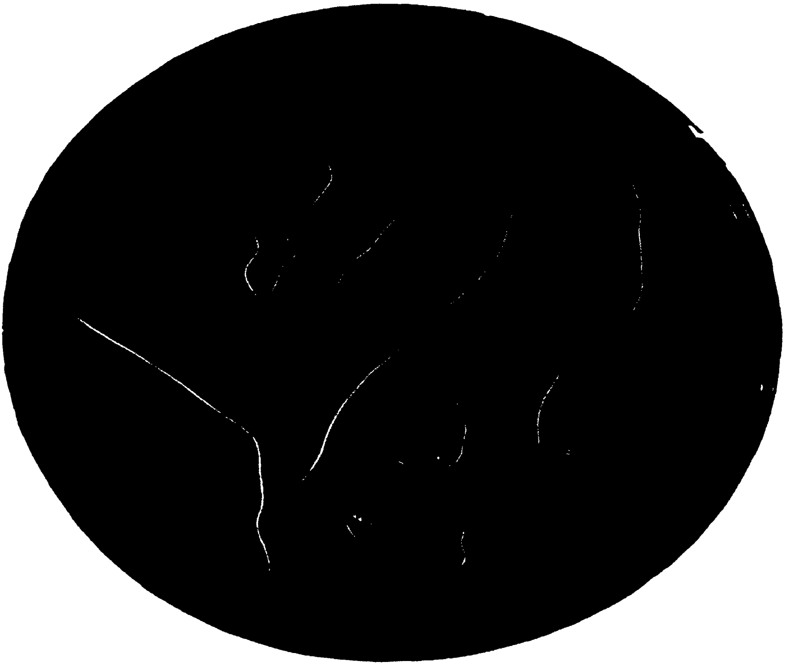

PLATE III
Adult lungworms (*Metastrongylus elongatus*). Natural size.

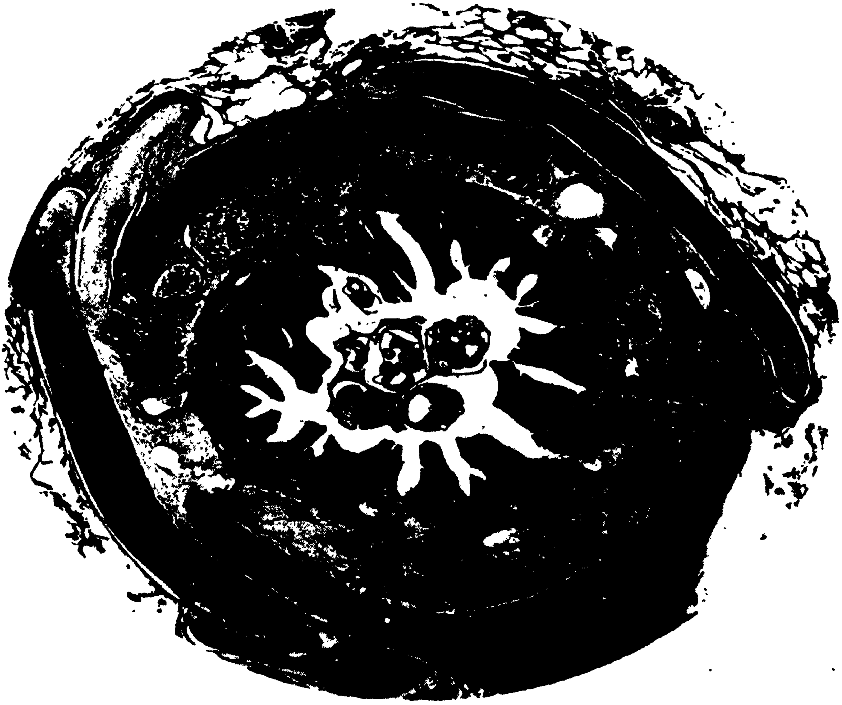

PLATE IV
Section of a bronchiole with lumen occluded by lungworms and mucus. Magnified 20 times.

PLATE V
Portion of a pig's lung showing lesions of lungworm infestation in the apical region.

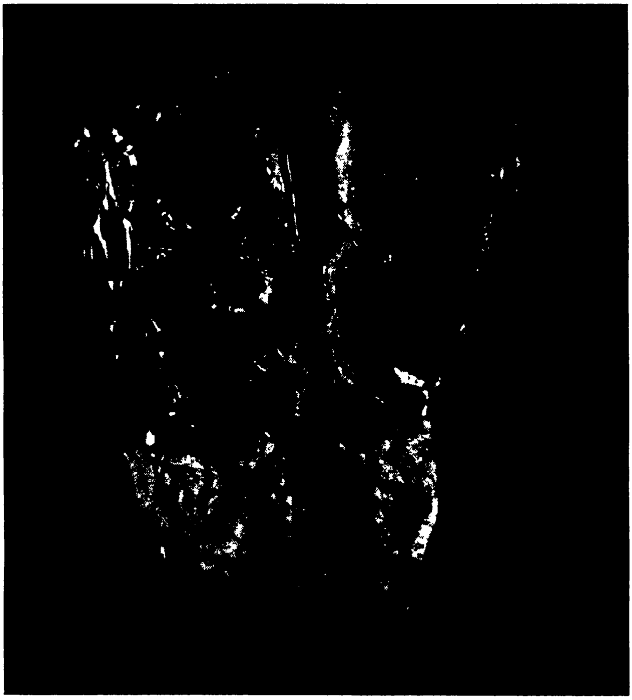

PLATE VI
Section of the same lung (Plate V) showing exposed bronchus with worms.

LUNGWORMS IN PIGS

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It is a truism that the increase of any animal is followed by an increase of its parasites. The rise in prosperity of the pig industry and the increasing incidence of worm diseases have left no doubt in the minds of pig producers about the truth of this statement. It is probably no exaggeration to say that parasitic worms cause more losses in pigs than all other diseases combined. These losses cannot be gauged exactly, but they must amount to a considerable sum every year. The presence of worms in a herd may mean the difference between success and failure.

An important fact that cannot be too strongly stressed is that the harmful effects produced by parasitic worms are not striking, and consequently their presence in a herd may pass unobserved. It is the slowly gnawing danger of the parasitic worm and the subsequent wastage and ill-health which it produces that is seldom realised.

The majority of pig producers are conversant with the large roundworm (*Ascaris*) in pigs and realise the importance of cleanliness, concrete floors, dung passages, etc., in regard to its control, but few are familiar with the lungworm (*Metastrongylus*) which is much more an outdoor than an indoor parasite. In this country pigs are liable to become infested with two species of lungworms. Both species inhabit the breathing-tubes of the lungs and produce similar disease symptoms. Only pigs that are allowed to root in ground containing earthworms are liable to become infested with lungworms. The explanation of this curious relationship between pig lungworms and earthworms is that the lungworm requires the earthworm as an intermediate host to complete its life-cycle.

Life-cycle.—The females in the bronchi and bronchioles of the pig give rise to very large numbers of eggs of microscopic size. As a rule hatching does not take place until the eggs are taken into the body of the earthworm, but a small proportion may hatch in the bronchi and intestine, or in the droppings. The eggs are expelled from the windpipe through the action of its lining which is provided with minute whip-like projections. On reaching the back of the mouth they are swallowed and finally expelled from the intestines with the droppings.

The hatching and further development of the parasite takes place in the food canal of the earthworm. The larvæ in their first stage are about 3 mm. long and are readily identified by their recurved tail ending in a swollen tip (Plate I). They develop to the infective stage in about 10 days. When infective they concentrate in the walls of the œsophagus, the blood-vessels, and especially the ‘ hearts ’ of the earthworm. The earthworm does not appear to suffer any discomfort from even very heavy infestations. The writer obtained approximately 4000 infective larvæ from the body of an earthworm which had been transferred for a period of 8 weeks to soil heavily infested with lungworm eggs. Plate II shows one of the ‘ hearts ’ of the earthworm packed with infective larvæ.

The infective larvæ do not escape at will from the body of the intermediate host, but if the earthworm is injured or dies, the liberated larvæ can survive for a period of two weeks.

Because of their habit of turning up vegetation, outdoor pigs become readily infested by ingesting infected earthworms. The larvæ present in the earthworms are liberated in the pig's intestines, and bore into the lymphatic glands of the gut wall, where further development takes place. Complete development to the adult stage is finally reached in the lungs after a period of about 6 weeks from the time of infection.

Economic Importance.—Reliable information on the economic importance of lungworms in pigs is extremely scanty. With the exception of Lewis's investigations in Central Wales (1926), no authoritative publication on their incidence is available for any district in Great Britain. Lewis noted that out of 137 pigs examined at the slaughterhouse at Aberystwyth, about 50 per cent were infested, the number of lungworms per host varying from 5 to 407. The ages of the pigs examined ranged from 4 to 15 months and older pigs were observed to be less heavily infested than younger ones.

From December 1936 to March 1937 a survey of the incidence of lungworms in pigs in the north-east of Scotland, as indicated by pigs arriving at a bacon factory, was made through the courtesy of Messrs Lawson & Sons, Ltd. The investigation was planned with the object of gaining information on the incidence and degree of infestation of lungworms in pigs reared for the bacon industry.

A total of 1009 pigs was examined, ranging from 6½ to 7 months of age and coming from the counties of Caithness, Ross and Cromarty, Nairn, Moray, Banff, Aberdeen and Kincardine, the majority being from Aberdeenshire farms. The pigs were typical baconers and showed no visible signs of worm infestation when delivered at the factory.

Method of Examination.—Each lung was dissected first along the main bronchi and then along the bronchioles towards the apex. The worms (Plate III), which are threadlike in appearance, are easily detected by reason of their whitish colour. Except in the case of a heavy infestation, when they may be found in any part of the lung, the parasites were almost invariably found in the bronchioles towards the apex of the lung. The worms were picked off with the aid of a forceps, preserved in 5 per cent formalin and afterwards identified.

Appearance and Pathology of Infested Lungs.—When lungworms are present in large numbers sufficient to occlude the finer bronchi and bronchioles (Plate IV) normal breathing is interfered with and a localised pneumonia is produced. The affected area of the lung (usually the apex) takes on a discoloured or mottled appearance (Plate V), the mottling being due to grayish pneumonic areas adjacent to whitish areas which have become distended with air. The affected portion of the lung is thus elevated or puffed up above the healthy part and this feature alone serves to distinguish a diseased from a healthy lung on microscopic examination.

On opening the lung along the bronchi and bronchioles the worms will be discovered lying in a thick mucus (Plate VI).

Although the health of mature pigs is seldom impaired by infestation from Metastrongyles, young pigs may be seriously affected and may die. As a rule, however, the parasites cause only a loss of condition and stunted growth. In its early stages lungworm infestation is characterised by a cough due to irritation of the lining of the windpipe and its branches produced by the migrating worms.

Species and Numbers of Worms Found.—Two species of lungworms were found to be present, *Metastrongylus elongatus* and *M. brevivaginatus*, the former much more commonly than the latter. The species can be readily distinguished by the fact that in *M. brevivaginatus* the male is much larger than in *M. elongatus*, while in the female the posterior extremity is straight, thus differing from that of *M. elongatus* which is strongly recurved.

Below is a summary of the results of the survey:—

Total Incidence—

(1)	Number of pigs examined	1009
	,, ,, infested	132
	Percentage of pigs infested	13·08
(2)	Number of consignments examined	148
	,, ,, infested	67
	Percentage of consignments infested	45·2

Incidence in Infested Consignments—

(3)	Number of pigs in infested consignments	460
	Number of infested pigs in infested consignments	117
	Percentage of infested pigs in infested consignments	25·4
	Minimum percentage of infested pigs in infested consignments	4
	Maximum percentage of infested pigs in infested consignments	100

Worm Counts—

(4)	Minimum number of worms per infested pig	1
	Maximum ,, ,, ,, ,,	65
	Average ,, ,, ,, ,,	11

Discussion of Results.—(1) It will be seen from the above that 13·08 per cent, or one in every eight, of the total number of pigs examined was infested with lungworms.

(2) The next set of figures perhaps demonstrates more clearly

the widespread distribution of lungworm disease. Actually 45 per cent, or almost half the total number, of consignments examined were infested. It has to be noted, however, that several consignments came from the same farm during the period of examination. The number of pigs in a consignment varied from 1 to 21.

(3) These figures are particularly interesting in view of the fact that they are closely connected with the remarkable life-cycle of the parasite. The results show that, on an average, in infested consignments only 1 pig in every 4 harbours the parasite, while it may be as low as 1 pig in 25 or as high as every pig in the consignment. This wide variation in the incidence of infestation is partly explained by the fact that the intermediate host, the earthworm, only becomes infected by a chance ingestion of soil containing lungworm eggs. Hence all earthworms in a piggery may not be infected, and, in addition, the infested earthworm may be eaten by a bird or migrate to ground outwith the piggery.

(4) While the degree of infestation was not sufficiently high to cause signs of lungworm infestation, it is to be noted that in almost every case where the number of worms exceeded 10 per lung, *the latter showed a pathological condition.* Unfortunately, the extent to which the health of the pig had suffered, if any, is not known. All that is known about the pigs is that they had a healthy appearance and had attained the standard of weight and condition required by the bacon factory. It may be concluded, therefore, that six-months-old pigs can harbour up to 65 lungworms without showing signs of ill-health or external evidence of lungworm disease.

It is interesting to note that a much higher degree of lungworm infestation was obtained in a local slaughterhouse where all types of pigs are slaughtered, including many of those which fail to reach the bacon factory standard. Out of a total of 224 pigs examined, 25 per cent were infested with lungworms. The average number of worms per infested pig was 18, with a maximum number of 110.

Incidence of Infestation in the different Counties

	Aberdeen	Ross and Cromarty	Banff	Kincardine	Moray	Caithness
Sources of Consignments ...	57	17	8	8	4	3
Number infested	29	9	2	3	1	1
Number heavily infested* ...	7	5	1	1	...	...
Number moderately infested†	22	4	1	2	1	1
Number free from infestation	28	8	6	5	3	2

* Infection considered HEAVY when over 25 per cent of pigs infested.

† When different consignments from the same farm were both infested and free from infestation, the infestation was counted as MODERATE.

From the above table it will be seen that slightly more than half the sources of the consignments in Aberdeenshire and Ross-shire are affected, while in Kincardineshire and Banffshire the disease seems to be less severe. Too much importance cannot be laid on these figures, however, as there is a wide discrepancy in the number of consignments examined in each county.

One point stands out clearly. In Aberdeenshire there is a prevalence of the milder type of infestation, while in Ross-shire the disease is more severe, the greater proportion of the infested consignments being heavily infested.

Prevention.—It can be readily understood from the life-cycle that any measures which prevent pigs eating earthworms will prevent lungworm infestation. By rearing pigs on concrete floors, therefore, complete control of the disease is effected.

Where pigs are being reared out of doors in small paddocks kept for the purpose, lungworms should be suspected, and especially is this the case if the ground is foul and seldom under the plough. Under the latter condition the infective larvæ will accumulate to dangerous proportions. No hard and fast rule can be laid down as to the maximum period during which pigs should be kept on the same ground, but if it is being constantly occupied by pigs and showing much excrement a shift to clean ground is advised. The best policy is to bring the pig-rearing ground into the usual farm rotation.

The length of time the infective larvæ can remain alive in the earthworm is not known, but the writer is investigating the problem. Infested earthworms were put into moist soil in the laboratory on the 4th December 1936. An examination of one of the earthworms made on the 26th May 1937 showed that the infective larvæ were still alive in its body. It is concluded, therefore, that the infective larvæ can remain alive in the intermediate host for at least six months.

Particular attention should be paid to the prevention of lungworms in young pigs, since young animals are more susceptible to the effect of infestation than mature animals. Pigs which acquire lungworms early in life tend to become more resistant to fresh infestations. A four-months-old pig, which has previously escaped infestation, is still highly susceptible to lungworms and may develop heavy infestations if put on to ground harbouring earthworms. Mature pigs possess a greater resistance to lungworms only because of early infestations from which they have recovered.

Treatment.—Pigs showing signs of lungworm infestation should be removed immediately to concrete pens. In order to prevent the spread of infection the pig manure should be spread on land not to be used for pig-rearing.

A well-balanced diet containing a liberal supply of concentrates and minerals will help the pigs to resist the effects of infestation and enable them to get rid of worms that are already present.

No satisfactory method for the destruction of lungworms in the bronchi has so far been discovered.

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Out-Wintering of Cattle and Winter's Pasture

THE following article is contributed by Mr Ian E. M. Sandison, Houlland, Baltasound, Zetland.

In the north isles of Shetland the practice of out-wintering cattle on a few natural pastures has been handed down the generations. Following this practice for the past twenty-five years I have had experience of out-wintering from twenty to sixty cattle annually, and there has always been a profit although a varying one. During the period from 1900 to 1914 cattle winterers expected a beast to 'turn itself over,' that is to double its value, from the time when it was put on the pasture at about 14 months old to the selling time 15 months later. For the past few years store cattle have been proportionally dearer and one was lucky to have about a 50 per cent increase in value in the grass-feeding period of about 15 months. Grazing costs vary as the rent of the pastures varies, *e.g.*, three acres a beast at 10s. an acre, and five acres a beast at 4s. an acre. The amount of net profit depends largely on the correct stocking of the pasture with beasts that will thrive throughout the winter and finish well in summer on grass alone, for in these days it is doubtful if the hand-fed bullock is not a loss to the feeder or to the Government. Had it been otherwise the cattle subsidy might not have been required.

To-day the type of cattle most favoured is the Aberdeen-Angus, for they suit the conditions, and where food is reasonably plentiful they are as hardy as the native breed. Shorthorns lose condition rapidly during severe weather, and although finishing well on the summer grasses they appear to be unable to use the winter's pasture to the same advantage. On my pastures over 40 per cent of the Shorthorn Crosses require a small amount of hand-feeding during the late winter or early spring, while not more than 10 per cent of the Aberdeen-Angus Cross or native cattle require to be fed. These out-wintered cattle not only stand the exposure and bitter gales that almost continually sweep across these isles, but finish quicker on the summer pasture than stall-fed cattle.

The pastures that are really suitable for out-wintering cattle show a decided growth of grass during the winter months, and to procure this growth it appears necessary that the plants should be allowed to form about three inches in bottom and eight inches in top grasses of foliage late in the summer. (A rich loam sown down with top and bottom grasses and cut each week throughout the summers with a lawn-mower—without a grass-box—showed a decreasing winter growth during the first four years, and for the following five years the grass lay practically dormant from October to May.) This late summer and early autumn growth of grass is beaten down by the equinoctial gales, and partly trampled by the cattle, and these conditions, aided by the temperate moist climate, start a new growth. Shelter is essential if the young grass shoots are to survive the boisterous climate, and the foliage not only forms a shelter for young shoots but when many varieties of grasses in an active state of growth are laid tillering commences, mostly above ground, and many of the stems lying on the moist earth act almost as temporary roots, producing fresh juicy shoots and leaves. Then at least one useful bent (*Agrostis stolonifera* Koch) roots at the nodes, growing all the time. Other plants of the fescue type are viviparous, and with this method of reproduction the stem must be laid and the panicle come in contact with the ground if the young shoots are to live. It is really a restocking of the pastures with young grasses without stopping green growth, somewhat similar to the gardener's method of layering, and this method of propagating trees has been found more effective than the transplanting of young trees in these isles. Growth under these conditions practically never ceases, for green leaves are to be found from the old stems and tillering shoots throughout January, February and March, while most of the close-cropped older grasses lie practically dormant and the seedlings do not come up enough to be of any use until the late spring. My experience shows that the cattle can look after themselves provided I look after the grazing, and this resting of the pasture for a month or six weeks in the late summer has in the long run proved the most economical method that I know of for maintaining the pasture's fertility and winter growth.

The capacity of a pasture to carry stock throughout the winter may I think be best judged in February and March. On rough hilly pasture I like to see Wavy Hair Grass (*Aira flexuosa*) showing a six-inch green leaf amongst the withered tufts, and a plentiful supply of Woodrush (*Luzula*) showing juicy active leaves. This rush appears to be unable to flourish on a pasture that has been depleted by years of over-grazing, unlike the Heath Rush (*Juncus squarrosus*) which may be growing in a healthy active state on pastures where even a Shetland sheep finds it difficult to survive. On the lower and better-class ground there should be a very decided growth of young leaves among which fescue, meadow grass, bent, foxtail, dogstail, and many others may all be sending up young shoots from one to four inches long amongst the laid straws.

A farmer's work consists largely of hard toil to provide fodder for the winter, and it may be that the winter growth of plants has received scant attention. Nature has provided a few useful evergreens even on northern hill pastures. Heath Rush (*Juncus squarrosus*) and the Great Woodrush (*Luzula sylvatica*) are two examples which under cultivation do not appear to respond readily in yielding a more rapid or palatable growth, but it may be that just as the cultivated oat differs from the wild variety so will some future evergreens differ from those I have mentioned. If even one genus is found it will save agriculturists many weary hours.

The Agricultural Wages (Regulation) (Scotland) Act, 1937

FARMERS and workers alike will be interested in the following outline of the main provisions of the Agricultural Wages (Regulation) (Scotland) Act, 1937, which received Royal Assent on 20th July.[1]

Agricultural Wages Committees.—The first step towards bringing the Act into effect lies with the Department of Agriculture for Scotland, who are charged with the duty of dividing Scotland into districts and of establishing an agricultural wages committee for each district. Power is reserved to the Department to vary the number and boundaries of the districts and the constitution of the committees affected in the event of the latter passing resolutions urging the desirability of such variation.

Each committee will consist of not more than eight and not less than five members representing employers, an equal number representing workers, two independent members appointed by the Department, and a chairman appointed by the committee, or, on their failing to do so, by the Department. The representative members of the committees will be chosen in a manner to be prescribed by regulations made by the Department.

Agricultural Wages Board.—The Department also have the duty of establishing the Scottish Agricultural Wages Board, consisting of six members representing employers, six members (including one woman) representing workers, and three members (one to act as chairman) appointed by the Department.

Minimum Rates of Wages.—The main duty of the committees will be to fix minimum rates of wages for all classes of workers employed in agriculture for time work. As a guiding principle it is laid down in the Act that in fixing rates ‘ a committee shall, so far as practicable, secure for able-bodied men such wages as in the opinion of the committee are adequate to promote efficiency and to enable a man in an ordinary case to maintain himself and his family in accordance with such standard of comfort as may be reasonable in relation to the nature of his occupation.’ A committee may fix rates applying universally to all workers in their district or to any special class of workers, or to any special area in the district or to any special class in a special area, subject in each case to any necessary exceptions in the case of employment of a special character, and varying according as the employment is for a day, week, month or other period or according to the number of working hours or the conditions of employment. Where a committee in fixing minimum rates provide for a differential rate in the case of overtime they are required to determine what employment shall be treated as overtime work. In addition, committees are required to determine what ‘ perquisites ’ shall be reckoned as payment of wages in lieu of cash, the extent to which they may be so reckoned and, subject to such general principles as may be defined in regulations to be made by the Department, the value at which they are to be reckoned. The Act provides that in fixing minimum rates of wages committees shall, so far as is reasonably practicable, secure a weekly half-holiday for workers.

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[1] Copies of the Act may be obtained directly, or through any bookseller, from H.M. Stationery Office, 120 George Street, Edinburgh, 2, and other addresses, price 3d. (postage extra).

Before they fix any minimum rates, or before they cancel or vary any rate previously fixed, a committee must give such notice—not in any event less than fourteen days—as may be prescribed by the Department and before reaching a final decision must consider any objections that may be lodged. When this procedure has been followed, the committee's findings are to be intimated to the Scottish Agricultural Wages Board, who are charged with the duty of making an order giving effect to the decisions and specifying a date, subsequent to the date of the order, from which they will take effect. It should be noted that since an order of the Board has legal force from the date specified therein, it will have from that date the effect of over-riding existing contracts between employers and workers, except where such contracts provide for a rate equal to or higher than the minimum fixed by the committee.

The Board have themselves no authority to fix, cancel or vary minimum rates, except (*a*) when a committee have failed to fix minimum rates within two months of their establishment, (*b*) when a committee have failed to fix a rate to replace one which has ceased to operate by reason of cancellation or otherwise, or (*c*) on receipt of a request in the form of a resolution by the representative members of a committee.

Piece-work.—Committees are empowered, but are not bound, to fix minimum rates of wages for piece-work. Where no such rates have been fixed, a worker employed on piece-work may complain to the appropriate committee that the piece rate which he is receiving is insufficient to yield a rate equivalent to the minimum rate for time-work. On receipt of such complaint the committee, after allowing the employer to make representations, may direct the payment to the worker of such sum as in their opinion represents the difference between the two rates. The amount specified in the committee's direction may be recovered by the worker from the employer as a civil debt.

Permits of Exemption.—Committees are authorised, on application made to them either by a worker or on his behalf, to grant a permit exempting the employment of the worker from the minimum rate provisions of the Act if they are satisfied that such worker is so affected by any physical injury or mental deficiency or any infirmity due to age or to any other cause that he is incapable of earning the appropriate minimum rate. A permit so granted may specify a minimum rate of wages which shall be applicable to the worker in question.

Penalties for Non-observance of Minimum Rates.—Any person who fails to pay to a worker wages not less than the minimum rate is liable on summary conviction, in respect of each offence, to a fine not exceeding £20 and not exceeding £1 for each day on which the offence is continued after the conviction. Whether there is a conviction or not the court may find the employer liable to make good past underpayments. Further, the Department are authorised to institute civil proceedings on behalf of or in the name of a worker when it appears to them that any arrears of wages are due on account of the payment of wages at less than the minimum rate or by reason of any direction by a committee for payment of an additional sum by way of wages for piece-work.

The Act lays down that it will lie with any person against whom proceedings are taken to prove that he has paid wages at not less than the minimum rate, and further that any agent of an employer is liable to proceedings and to conviction for an offence in the same manner as if he himself were the employer.

Agreements for the Payment of Wages.—Any agreement for the payment of wages in contravention of the Act or for abstaining from exercising any right of enforcing the payment of wages at the minimum rate is void. The Act contains the important specific direction that nothing in its provisions shall prejudice the operation of any agreement or custom for the payment of wages at a rate higher than the minimum rate fixed under the Act.

Cost of Administration.—The expenses of the Department and any authorised expenses incurred by the committees or by the Board in the performance of their duties under the Act will be defrayed, up to an amount approved by the Treasury, out of moneys provided by Parliament.

Appointment and Powers of Officers.—The Department are empowered to appoint a secretary to the Board and to each of the committees as well as such officers as they think necessary for the purpose of investigating complaints and otherwise securing the proper observance of the Act. These officers are authorised to require the production of and to inspect wages sheets or other records, to enter premises at all reasonable times for such inspection and to require any worker or employer to give information with respect to the worker's employment or wages. Any person hindering an officer in the execution of his duty, or refusing to give information on request, or giving false information is liable on summary conviction to a fine not exceeding £20 or imprisonment for not more than three months, or both.

Definitions.—In the Act 'agriculture' includes dairy-farming and the use of land as grazing, meadow, or pasture land or orchard land or woodland or for market gardens or nursery grounds; 'worker' includes a boy, woman and girl; and 'employment' means employed under a contract of service or apprenticeship.

Arrangements are being made, in consultation with the organisations representing the interests of farmers and farm workers, to settle the districts and establish the district committees and the Board. The making of the regulations and the arrangements for the selection of representative members of the committees will occupy some weeks, but it is anticipated that the committees will be fully established and in a position to arrive at decisions early in the new year. In making the arrangements the Department are working in close conjunction with the National Farmers' Union of Scotland, the Scottish Chamber of Agriculture, and the Scottish Farm Servants' Union, all of whom have indicated their willingness to co-operate fully with the Department in the duty of giving effect to the provisions of the Act.

The Agriculture Act, 1937

AN account was given in the issue of this JOURNAL for July of the provisions of the Agriculture Bill as they stood when the Bill was read a second time in the House of Commons.

The only substantial alteration made afterwards deals with the right to receive payment of subsidy on oats and barley in cases where a change has taken place in the occupation of the farm in question. So far as Scotland is concerned, Section 33 (*d*) provides that in such cases the outgoing occupier, if entitled to harvest the crop or to receive payment therefor, shall be entitled to receive payment of the subsidy instead of the occupier of the farm on 4th June.

Eleventh World's Dairy Congress, Berlin, 1937

THE inauguration of the Congress took place in the Kroll Opera House, Berlin, on 20th August. Representatives were present from fifty-four nations, while the number of members and delegates attending was about 3,700, over 200 of whom were from Great Britain.

Herr Walther Darré, the German Minister for Food and Agriculture, after welcoming the delegates, said that the dairy industry had played an important part in the life of the German nation. The number of cows in milk had of late years been increasing and was now over ten millions. Every effort was being made to improve both the yield and the quality of the milk produced and special legislation with that end in view had been passed, while much useful work had been done by German scientists. Herr Darré and those responsible for the organisation of the Congress were impressed by the response made to the various questions asked, no fewer than 400 papers full of valuable suggestions having been received.

The work of the Congress was divided into four sections, as follows:—

Section I—Milk Production.
,, II—Milk Processing and Treatment.
,, III—Legislation on the Sale of Milk and its Products, Business Management and Dairy Education.
,, IV—Dairy Equipment, Machinery, Buildings and Means of Transport.

These sections were further divided into topics, thus enabling the various papers relating to any particular topic to be summarised by a reporter. The summaries were printed in German, English and French for the use of members.

During the sectional meetings the reporters also gave summaries of the papers before discussion. A simultaneous translation apparatus enabled all present to follow the summaries and the discussions in one or other of the above-named languages.

Amongst the papers contributed by British authors the following may be mentioned:—

Section I. 'The Value of Silage and Artificially Dried Grass in the Feeding of the Dairy Cow,' by Dr S. J. Watson; 'The Protein Requirements of Dairy Cows,' by S. Bartlett, S. L. Huthnance and J. Mackintosh; 'The Use of Milk Records in the Feeding and Breeding of Dairy Cows,' by J. Mackintosh; 'Variations in the Milk Yield of the Daughters of Different Bulls,' by A. D. Buchanan Smith and O. J. Robinson; 'The Eradication of Bovine Contagious Abortion,' by Doyle; 'The Effect of Proved Sub-Clinical Mastitis on the Manufacture and Quality of Cheddar Cheese,' by Mattick, Davies and Dearden; and 'Bloat in Dairy Cows,' by Dr M'Candlish.

In Section II there were several papers from the National Institute of Dairying at Reading, while 'The Condensing and Drying of Milk,' by G. R. Howat, C. J. Jackson and A. A. Nichols, indicated some of the problems studied at the Hannah Institute.

In Section III a paper was contributed by Holmes on dairy education, another by Gosney dealt with the marketing of milk products in Great Britain, while the National Milk Publicity Council contributed a paper on milk publicity in England. Papers on cheese-making were contributed by Taylor, Great Britain, and by some New Zealand workers.

Paper-reading sessions were held during the morning hours from 23rd to 26th August, the afternoons of these days being devoted to excursions to farms, educational institutions, depots for collecting, manufacturing and distributing milk, and other places of interest in the neighbourhood of Berlin. The closing meeting took place on 27th August, when the various reports and resolutions put forward by the Committees were submitted to the Congress. Thereafter a number of excursions designed to give visitors a more intimate view of the dairying industry in Germany were undertaken. These lasted for a period of two and a half days, after which a number of longer trips were begun.

During the period of the Congress the members had an opportunity of visiting the International Dairy Exhibition which was staged in vast exhibition buildings recently erected near the Radio Tower in Berlin. The main purpose of this Exhibition was to show the high state of development which the modern dairy industry had attained in the civilized countries of the world. This was carried out by illustrating all matters connected with the production, processing, and marketing of milk and its products.

One of the most interesting parts of the Exhibition was the national exhibits. As might be expected, the Baltic countries, Denmark, Norway, Sweden, Finland, etc., being largely engaged in exporting milk products, had well-equipped stands. The Italian stand, where wool and cloth made from milk were shown, attracted a considerable amount of attention, while the German stand exhibited in a very impressive manner the part played by the German dairy industry within recent years. Stands were provided by two English-speaking countries—England and the Union of South Africa.

An exhibit of the breeds of dairy cattle in Germany comprised seven breeds of cows, while in another section goats and milk ewes, both of which contribute a considerable supply of milk in certain parts of Germany, were to be seen. The greater part of the space allotted to exhibitors was, however, taken up by exhibits of dairy machinery.

The Congress showed much interest in the problem of standardising methods of milk-recording and of the proper interpretation of its results in subsequent breeding—longevity and life-performance being cases in point. Attention was drawn to the great wastage caused by such diseases as abortion, tuberculosis and mastitis, all of which are in some degree a menace to the health of human beings. It was felt, too, that considerable improvements might be made in the matter of applying tests to milk and its products. On the question of processed cheese the desirability of freedom from adulteration and the need for proper nomenclature were emphasised.

Noteworthy amongst the decisions taken was that on the subject of hygienically produced milk. The need for producing such milk was stressed, but mainly from the point of view of improving the quality of the milk prior to pasteurisation. The finding of the Congress was as follows:—

'Hygienic milk production, based on sanitary control in the cow-house and on measures conducive to the lowest possible content of microbes in the milk, must aim at the production of a milk easy to pasteurise, *i.e.*, of a milk free from thermoduric micro-organisms and suitable for milk pasteurisation. The purpose of this pasteurisation is to secure the absolute destruction of the pathogenic germs as well as the raising of the keeping quality to a satisfactory degree, but without injuring the natural nutritive and industrial qualities of the milk. This must be made possible by a simple, economic and preserving method of pasteurisation.'

The need for more attention being given to the technique of dairy education was also recognised, and it is expected that a discussion of this subject will be one of the features of the next Congress, which is expected to meet in Vienna in 1940.

The whole Congress was a triumph of organisation. Members from all countries were unanimous in their praise of the efficiency of all the arrangements and of the hospitality and kindness extended to them by the German Government, by the German Dairy Industries and by the various officials connected with the Congress.

Studentships for Research in Animal Health

On the recommendation of the Agricultural Research Council, the Department have awarded to Mr John W. Whittick, B.Sc., M.R.C.V.S., a Studentship for Research in Animal Pathology of an inclusive value of £300 per annum, tenable, as from 1st October 1937, for not more than three years. It has been decided that, during the first year, Mr Whittick should engage in research into human pathology, working under the supervision of Professor H. M. Turnbull in the Department of Pathology at the London Hospital.

The Council have also recommended that Mr John B. Brooksby, B.Sc., M.R.C.V.S., who last year was awarded a Studentship for Research in Animal Physiology, tenable at University College, London, should spend the second year working under the supervision of Prof. J. B. Collip, F.R.S., in the Biochemical Department of McGill University, Montreal. In addition to Mr Brooksby's Studentship allowance of £300, the Department have been authorised to pay an amount not exceeding £50 in respect of his travelling expenses.

Reviews

(1) *Grass Drying*. E. J. Roberts, M.A., M.Sc. Issued by the Agricultural Research Council. London: H.M.S.O., 1937. 2s.

(2) *Grass Drying: A Study of Production Costs in* 1936. R. N. Dixey and R. P. Askew. Pp. 45. Oxford: Agricultural Economics Research Institute, 1937. 1s.

No recent development in the agricultural industry has attracted more widespread attention than that of grass drying. The possibilities of cutting down the losses in haymaking and of producing a home-grown food comparable in value with that of a purchased feeding stuff are in themselves so attractive that the development of this process is a matter of interest to all farmers. Hitherto there have been considerable differences of opinion in regard to the costs of production. Most of the pioneers of grass drying were inclined to base their conclusions on insufficient data, while many of the difficulties, seasonal and otherwise, were underrated.

(1) For the purpose of carrying out an exhaustive and comprehensive survey of the whole subject of grass drying the Agricultural Research Council were most fortunate in securing the services of Mr E. J. Roberts, of University College, Bangor.

The problems facing the farmer who decides to dry his grass are many and varied. He must, in the first place, be prepared to produce herbage of a suitable nature. Such factors as the effect of weather, of manuring, of frequent cutting, of the original composition of the sward and of the maintenance of its yield have all to be seriously considered. Each of these factors is fully discussed by Mr Roberts, who emphasises the importance of quality in the herbage. It costs the same to dry a ton of inferior herbage as to dry a ton of first-rate grass, while the latter is of much more value for feeding than the former. That this point has been insufficiently realised is shown by the fact that in 1936 much of the processed material had a value little in excess of that of first-class hay.

One of the main difficulties the grass-drying farmer has to face is the question of water evaporation. Thus from fresh grass containing 80 per cent of moisture one ton more of water has to be evaporated than from herbage of 75 per cent moisture content in order to produce one ton of dried material. As the moisture content of grass may vary between 72 and 85 per cent, the difficulty of giving even an approximate figure of the cost of drying may be realised.

Questions of cutting and haulage are fully dealt with, while the important subject of the relative efficiency of the different grass-drying plants in all its phases—fuel consumption, output per hour, and quality of output—is thoroughly discussed.

The crucial question is 'Is it worth while?' Of the value of dried young grass there can be little doubt. It is claimed that weight for weight it can replace a high-class cake in the animal's ration. Furthermore, winter milk produced from dried grass has the rich colour of summer milk, while decided improvements are said to have been noted in the health of animals fed on dried grass or fed on the milk produced from such animals. Mr Roberts deals very carefully with these claims, pointing out that in some respects they have been over-stated and that there has been a tendency to over-value the material, particularly where the quality is not of the best. In the main, however, the finished product produced from suitable herbage is undoubtedly a very valuable live-stock food. The relatively high cost of production per ton, which on the farms under review came to £5, 17s. 5d., together with the low output per hour and the heavy capital expenditure involved in setting up a plant are, however, factors which must be seriously considered before the future of grass drying as a commercial proposition can be assured.

Mr Roberts is to be congratulated on his lucid, able and impartial presentation of the case for grass drying. Having regard to the fact that his findings are largely based on the results obtained in the year 1936—a year which, because of the excessive rainfall, was an unusually difficult one for the grass-drying farmer—and the fact that everything connected with the process is yet in its elementary stages, there does seem to be ground for believing that there is a commercial future for the process.

(2) The object of Messrs Dixey's and Askew's survey was to examine evidence from a limited number of farms in order that fairly accurate figures of the cost of production of dried grass might be given. Costs were accordingly collected from five farms in the South Midlands. On three of these farms Billingham driers

were used; on the other two, one Ransome and one Curtis-Hatherop were worked respectively.

The authors are to be congratulated on the clear and unbiassed manner in which they present their facts and draw their conclusions. Fuel costs together with the power necessary to operate the plant are stated to amount to 33s. 3d. per ton of dried grass produced; depreciation and repairs amount to 23s. 2d.; labour, in the field to 9s. 8d. and at the drying plant to 19s. 7d. The total costs per ton amount to £5, 18s. 6d., a figure which agrees closely with that arrived at by Mr Roberts. It is rather high to augur well for the future of the process unless it can be shown that these costs are largely of a pioneer order and that considerable economies in production can be effected. The authors are of the opinion that there is considerable room for the cutting down of both labour and power costs. They doubt, however, whether proportionate savings can be effected in the matter of fuel.

One chapter is devoted to a discussion of the value of the product. Considerable variations in the protein analysis of different samples appear to have occurred. These suggest that equally wide variations in results might occur when different samples of dried grass were subjected to critical feeding tests. So far, there is insufficient evidence to show that much of the dried grass produced may not have the value of a high-class concentrated food, but there are strong presumptive reasons for thinking that a great deal of dried grass falls below this level.

The authors rightly stress the fact that their investigations were only preliminary, and they therefore do not attempt to draw definite conclusions. Many technical difficulties are associated with the process, and until these can be solved and until the value of the product can be accurately determined, it is perhaps futile to speculate on the future of grass drying. One aspect which must not be ignored, however, is that of dried grass in a plan for national defence in time of war. It is to be hoped, therefore, that grass-drying investigations will be continued and that all possible light will be thrown on the subject.

Profit from Fertilizers. H. V. Garner, A. H. Hoare, H. C. Long, R. G. Stapledon, F. Rayns, T. Wallace. Pp. 176. London: Crosby, Lockwood & Son, Ltd. 1936. 7s. 6d.

The opening chapters of this book are written by Mr Long and Mr Garner; they provide an introduction to plant nutrition, touch on the losses of nutrients from the soil, and give a detailed account of the compounds commonly employed to increase soil fertility. There is also a chapter which contains very full quotations from the literature issued by Imperial Chemical Industries in respect of their new concentrated fertilizers.

The principal part of the book, which deals with the actual use of fertilisers, commences with a section on grass land by Professor Stapledon. Drawing on his experience at the Welsh Plant Breeding Station and the Cahn Hill experiments, he has summarised, in a very readable form, much of the information he has already published on the management and fertilization of lowland and hill grass.

Mr Rayns, in an excellent chapter on the manuring of arable crops, is rather more successful than his collaborators in producing evidence as to the *profitableness* of manuring. He deals adequately with all the ordinary arable crops; his section on the manuring of sugar beet is particularly good and is worthy of the attention of all beet growers. It is interesting to observe that after his wide experience of agricultural education and experimentation, Mr Rayns puts in a good word for the manure merchant's ' compound ' and suggests that, for all practical purposes, apart from nitrogenous top dressings, two compound manures should serve all the needs of the arable farmer.

The chapter on the manuring of fruit crops, which is written by Dr Wallace, is based largely on evidence obtained at such experiment stations at Long Ashton and East Malling. The author's recommendations have a sound scientific basis, and he deals with many of the fruit-grower's difficult problems such as, for example, those connected with undercropping and manuring for both yield and quality. He has written a first-class summary for fruit-growers and his matter is of very great interest to the general agriculturist.

In his section on market garden and flower crops, Mr Hoare has suggested different fertilizer ratios for a large number of species, but he is at a disadvantage in having insufficient evidence from British experiments and in being obliged to quote American recommendations. He has overlapped the ground covered by the opening chapters, and his suggestions regarding the preparation of compounds on the farm are open to criticism.

While the sections of this book lack uniformity in quality, and even reveal differences in principle, certain of the chapters written by specialists make the volume a useful addition to agricultural literature.

The Handbook of Modern Pig Farming. H. M. Rikard-Bell. Pp. 128. London: H. F. & G. Witherby, Ltd. 1937. 3s. 6d.

Within the past decade great advances have been made in the technique of all matters relating to pig feeding and management. It is therefore fitting that most of the up-to-date information should be presented to farmers in a readable and compact form.

Mr Rikard-Bell's book sets itself out to show how the average man with his varying degrees of financial equipment can take advantage of the best methods of breeding, housing and feeding pigs. It does not limit itself to showing what can be accomplished with large-scale and up-to-date pig units, but indicates how the peculiar problems of the smaller man can be solved.

The first chapter deals with breeds. Such points as fecundity, general thriftiness, ability to produce a first-class bacon carcase, and early maturity are all discussed. For bacon purposes the pure-bred Large White breed is advocated. For pork purposes the merits of the pure-bred Berkshire and those of the cross between the Large White and Middle White appear to be equal.

The importance of careful selection for laying the foundation of the herd is suitably stressed by the author, who gives considerable prominence to such subjects as housing and the many other things that may be comprised under the name 'good management.' The need for comfort, adequate ventilation, sunshine and cleanliness are all commented upon. For farmers who can afford the capital, the Danish house is commended as an investment likely to give large returns. The use of concrete flooring is not, however, commended unless steps have been taken to provide suitable insulation; it is said to have been fruitful of many evils such as cramp, rheumatism, etc.

A considerable amount of space is devoted to feeding stuffs and rations. The methods of working out the unit values and of compounding rations are clearly shown by suitable examples. The author is probably on less sure ground when he commends the use of as much as 35 per cent maize meal in a fattening ration. In the opinion of many pig men qualified to know the effect of feeding so much maize might be to give an undesirable fat in the carcase, particularly if it be tank-cured. No other adverse comment suggests itself.

The book places before the farmer in a very readable manner a large amount of valuable and interesting information. It is admirably illustrated with 16 plates and diagrams.

Agricultural Progress: *Vol. XIV, Parts I and II.* Cambridge: W. Heffer & Sons, Ltd. 1937. 2s. each.

Agricultural Progress, the Journal of the Agricultural Education Association, is now being issued in three parts yearly instead of in one annual volume. Like those of previous issues the contents of Parts I and II of Volume XIV are largely devoted to reproducing the various papers read to the Association at its winter and summer conferences. In addition, a considerable amount of space has been allocated to a series of special articles dealing with the genesis and history of agricultural education in this country.

From the able and facile pen of Sir John Russell comes the intriguing story of Rothamsted. Here indeed is a fit example of the advantages of team work. Lawes, the man of imagination, of bold ideas and lofty conception, found his complement in Gibert, a worker with a wonderful aptitude for detail. The combination of these two men was almost ideal for scientific purposes. For sixty long years they were in scientific partnership. Of the latter struggles and difficulties of Rothamsted and of its eventual triumph in acquiring the land on which the historic experiments had been located, the story is told in most fascinating fashion. The other papers deal mainly with Scottish agriculture—land reclamation, the agriculture of the South-West of Scotland, bracken eradication, the Ayrshire early potato industry, etc.

In Part II Professor J. A. Scott Watson writes of the history of the Chair of Agriculture in Oxford. The first Sibthorpian Professor was a botanist, and for many years after the chair was established little or no interest was taken in the science of agriculture. Indeed, after Gilbert of Rothamsted was appointed in 1884, it is stated that some of the elderly dons were shocked to learn that an academic colleague was discoursing on the subject of manure!

Educational problems are discussed by Principal J. C. Leslie of Chelmsford, who writes on the County Farm Institute, and by Mr T. S. Dymond, whose subject is 'Education for Rural Life.' Mr Dymond's wide experience both as an agricultural scientist and as an Inspector of Schools warrants his ideas being given thoughtful consideration. He is in full sympathy with a vocational bias being given to all education and is of opinion that the extra school year should be utilised to train the child to begin its future career with considerable experience of the technical aspect of the work proposed to be entered upon. Mr C. S. Orwin discusses a national policy for agriculture, Dr J. S. Watson contributes an able paper on dried grass, Dr S. K. Kon writes on the effect of heat on the nutritive value of milk, and other valuable articles are included.

Farm Machinery and Equipment. Harris Pearson Smith. London: M'Graw-Hill Publishing Co., Ltd. 16s.

This is the second edition of this book, in which nearly all the material has been rewritten and many new illustrations have been added.

The contents are a portrayal of American agricultural practice and consequently many of the machines described are unfamiliar in this country. Nevertheless, the book contains much that is common to the agriculture of both countries and should form a very useful addition to all reference libraries, since it is common practice nowadays to study the methods of agricultural production in other countries with a view to the adoption of any type of machine that might be suitable for solving any of our domestic problems of production.

Part I discusses farm machinery and its relation to agriculture. Part II gives five understandable chapters on mechanics, friction and its remedy, materials of construction, transmission of power, elements of machines and an interesting chapter on selection of farm machinery from an American point of view. The next section includes eight chapters dealing with machinery for the preparation of the soil, and comprises many useful illustrations showing the principles of hitches and the construction and management of ploughs. Next follows a section on seed-bed preparation machinery, then seeding machinery and an interesting chapter on row-crop cultivators and dusting and spraying machinery, while in logical sequence there come sections on machines for harvesting, seed preparation, feed preparation and fertilising, transportation equipment, cleaning and grading machinery and machines employed in the conservation of soil and water.

The book covers a very wide range of machines in a lucid and compact manner and is very liberally illustrated.

The Hill Lands of Britain. Prof. R. G. Stapledon. Pp. 138. London: Faber & Faber, 1937. 6s.

This is a book written by an enthusiast, but with an appeal to all who have the present and future of humanity at heart. It deals, like the author's previous book (*The Land : Now and To-morrow*), with the improvement of hill lands, but in the present work he treats the scientific aspect, on which he is the world's greatest authority, only as a background to a more logical development of the non-material amenities of this portion of our country.

In the first two chapters Professor Stapledon shows the need for prompt and comprehensive action by way of developing these vast resources, now wasted as far as the majority of our nation is concerned. In the subsequent chapters he gives details of the ways and means, both technical and administrative, of a plan whereby this action could immediately be put into effect.

Guide to Current Official Statistics.—Conspicuous among the various public services which are provided directly by the State is the publication every year by the Stationery Office of a very large number of volumes containing statistics collected through official channels. The range of the subjects dealt with is so wide, and the degree of detail in which they are examined so varied, that this store of information cannot be utilized to the best advantage without a single systematic index to the contents of all statistical publications of this nature. Such an index has been in existence for a number of years, a new volume, dealing with the statistics published in the preceding year, being issued annually. From this index, the nature of the information available on any subject, and the official publication in which it is contained, can be readily ascertained.

The title of this extremely useful handbook is *The Guide to Current Official Statistics.* Volume Fifteen, relating to the official statistics published in 1936, was published in July. It contains over 400 pages, and is obtainable from the sale offices of H.M. Stationery Office, or through any bookseller, for one shilling (by post 1s. 6d.).

Wireless Talks on Agriculture

SCOTTISH

DATE	SUBJECT	SPEAKER
November 4	Grass Drying	A. B. Fowler
,, 11	Topical Talk	Joseph F. Duncan
,, 18	A Hill Hirsel	John Dickson

NATIONAL

DATE	SUBJECT	SPEAKER
November 3	The Ewe Flock	W. S. Mansfield
,, 10	Wintering Cattle	do.
,, 17	Systems of Farming	W. S. Mansfield and R. M'G. Carslaw
,, 24	Basic Slag	W. S. Mansfield
December 1	Poultry	do.
,, 8	The Smithfield Show	do.
,, 15	Odd Jobs	do.
,, 22	Pigs	do.
,, 29	Land Drainage	do.

This list may be subject to slight alteration

Mr W. S. Mansfield is a Fellow of Emmanuel College, Cambridge, and is Manager of the University Farm.

Unemployment in Agriculture

The following figures of unemployment in agriculture and allied industries have been supplied by the Ministry of Labour:—

INSURED AGRICULTURAL WORKERS,* AGED 14-64, RECORDED AS UNEMPLOYED AT 23RD AUGUST 1937.

INDUSTRY	MEN		BOYS		WOMEN		GIRLS		TOTAL
	21-64	18-20	16-17	14-15	21-64	18-20	16-17	14-15	
Farming, Forestry, etc.	2,222	297	213	92	257	74	62	26	3,243
Market Gardening, etc.	307	60	46	38	71	21	43	24	610
Other Gardening* ...	184	13	5	3	4	3	...	2	214
TOTAL* ...	2,713	370	264	133	332	98	105	52	4,067

* *Excluding Private Gardeners, who numbered* 214

The following table shows the numbers of wholly unemployed men and women, aged 18 years and over, registered at Unemployment Exchanges in Scotland at 7th June 1937, as applicants for work in agricultural and allied occupations:—

	Men	Women	Total
Farm Worker . .	1,080	37	1,117
Farm Labourer . .	909	105	1,014
Poultryman . .	55	7	62
Fruit, etc., Picker .	326	67	393
Forester . . .	69	0	69
Forester's Labourer .	38	0	38
Gardener, etc. . .	275	13	288
Gardener's Labourer .	233	29	262
All Occupations . .	2,985	258	3,243

The following are the counties with the largest numbers:—Lanark, 649 (607 men, 42 women); Angus, 281 (263 men, 18 women); Midlothian, 270 (227 men, 43 women); Ayr, 253 (229 men, 24 women); Aberdeen, 246 (245 men, one woman); Inverness, 148 (144 men, 4 women).

Agricultural Returns for Scotland, 1937

The Preliminary Statement of the Agricultural Returns taken in Scotland as at 4th June 1937 shows that the total area under crops and grass amounts to 4,570,400 acres, comprising 2,981,400 acres of arable land and 1,589,000 acres under permanent grass. The total acreage is the smallest recorded since 1873 and is less by 22,000 acres than that returned in 1936. The area of arable land is greater than in 1936 by 5,000 acres, but is otherwise the smallest area recorded since the Returns were first taken in 1866. The area under permanent grass is smaller by 27,000 acres than in 1936.

The area under rotation grasses and clover, 1,440,000 acres has increased by 10,000 acres, while the tillage area, *i.e.*, arable land exclusive of that under rotation grasses and clover, is smaller by 5,000 acres than in 1936. Reductions in the areas under oats, beans, peas, turnips and swedes, cabbage, rape, vetches, tares, etc., for fodder, and 'other crops' amount in all to 33,200 acres. Increases in the areas under wheat, barley, mixed grain, rye, potatoes, mangolds, sugar beet, small fruit and bare fallow show a collective total of 21,200 acres.

Wheat shows an increase of 6,000 acres, or 6·4 per cent, compared with 1936, while the area under barley also increased by 10,000 acres, or 13·9 per cent. Oats, however, have decreased by 13,000 acres to 816,000 acres. The area under potatoes has increased by 2,000 acres to 135,000 acres, while that under turnips and swedes has decreased by 14,000 acres to 332,000 acres.

Of the area under permanent grass, 184,000 acres were cut for hay, and 1,405,000 acres were grazed, while of the area under rotation grasses and clover, 410,000 acres were cut for hay and 1,030,000 acres were grazed. The area under permanent grass for mowing was greater than in 1936 by 14,000 acres and that under rotation grass for mowing was greater by 13,000 acres; the total area cut for hay is thus increased by 27,000 acres.

The live-stock returns show that horses remain almost unchanged in number, that cattle and sheep have decreased, and that pigs have increased.

Horses used for agricultural purposes are fewer than in 1936 by 1,500, the total, 108,500, being the smallest on record. Unbroken horses over one year old and foals are more numerous by 800 and 400 respectively.

The total number of cattle, 1,294,000, is less than in 1936 by 19,000, or 1·4 per cent. Cows in calf, heifers in calf and bulls being used for service are more numerous, but the other four classes show decreases; the class of 'other cattle' one to two years old is smaller by 13,500 or 4·1 per cent.

The total number of sheep, 7,503,500, is less by 53,500, or 0·7 per cent, than in 1936. All classes share in the decrease, ewes being fewer by 28,000, or 0·8 per cent; rams by 1,500, or 1·5 per cent, other sheep one year and above by 9,000, or 1·0 per cent, and lambs by 15,000, or 0·5 per cent.

Pigs show a slight increase of 5,600, sows being more numerous by 2,000, or 6·9 per cent, boars by 200, of 7·1 per cent, and other pigs by 3,400, or 1·7 per cent.

The returns of poultry are given below. Fowls show a decrease of nearly 655,000, or 8·2 per cent, and ducks one of 19,000, or 8·1 per cent. Geese also show a decrease of 1,500, or 5·7 per cent, but turkeys show an increase of 20,300, or 21·0 per cent.

	1937	1936
Fowls over six months old . .	3,650,000	3,780,200
Fowls under six months old . .	3,650,000	4,174,300
Ducks over six months old . .	140,000	147,500
Ducks under six months old . .	77,000	88,500
Geese over six months old . .	8,300	8,700
Geese under six months old . .	16,300	17,400
Turkeys over six months old .	17,100	16,100
Turkeys under six months old .	100,000	80,700

The returns of labour employed at 4th June (excluding occupiers of holdings, their wives, and domestic servants) are given below. Regular male workers are fewer than in 1936 by 1,100, and regular female workers also show a decrease of 100. Casual workers, however, show an increase of 800.

	1937	1936
Regular Workers—		
(*a*) Males, 21 years old and over .	59,300	59,700
(*b*) Males under 21 years old . .	19,200	19,900
(*c*) Women and Girls . . .	16,300	16,400
Casual Workers—		
(*a*) Males, 21 years old and over .	6,900	6,400
(*b*) Males under 21 years old . .	2,700	2,800
(*c*) Women and Girls . . .	5,800	5,400
Totals . . .	110,200	110,600

There is given below a Preliminary Statement, compiled from the returns of varieties of potatoes grown in 1937, of the acreage as at 4th June under the principal varieties, together with the figures for 1936. The acreage accounted for here is 115,200 acres, the remaining 20,000 acres not being included in the returns of varieties.

	1937 acres	1936 acres
First Earlies—		
Arran Pilot	1,100	800
Duke of York	1,500	1,400
Eclipse	2,300	2,700
Epicure	9,200	9,600
Sharpe's Express	2,300	1,800
Others	1,300	1,400
Totals	17,700	17,700
Second Earlies—		
Great Scot	6,500	7,600
British Queen	2,100	2,500
Others	2,000	1,800
Totals	10,600	11,900
Maincrops—		
Arran Banner	2,800	2,800
Doon Star	4,400	2,800
Golden Wonder	7,300	8,000
Kerr's Pink	37,200	36,700
Majestic	16,900	15,000
Redskin	1,300	200
Arran Chief	1,000	1,200
King Edward VII	11,600	14,400
Others	4,400	4,500
Totals	86,900	85,600

CROPS AND GRASS.

DISTRIBUTION	1937 (*b*)	1936	INCREASE		DECREASE	
	Acres	*Acres*	*Acres*	*Per Cent*	*Acres*	*Per Cent*
TOTAL AREA (excluding WATER)	19,069,000	19,069,000	..	..	..	..
TOTAL ACREAGE under all CROPS and GRASS (*a*)	4,570,400	4,592,400	..	..	22,000	0·5
ARABLE LAND	2,981,400	2,976,400	5,000	0·2	..	..
PERMANENT GRASS (*a*) { For Hay	184,000	170,000	14,000	8·2	..	..
PERMANENT GRASS (*a*) { Not for Hay ..	1,405,000	1,446,000	..	..	41,000	2·8
TOTAL	1,589,000	1,616,000	..	..	27,000	1·7
Wheat	100,000	94,000	6,000	6·4	..	..
Barley (including Bere)	82,000	72,000	10,000	13·9	..	..
Oats	816,000	829,000	..	..	13,000	1·6
Mixed Grain	2,400	2,300	100	4·3	..	..
Rye	2,700	2,500	200	8·0	..	..
Beans	2,300	2,800	..	..	500	17·9
Peas	700	800	..	.	100	12·5
Potatoes	135,000	133,000	2,000	1·5	..	..
Turnips and Swedes	332,000	346,000	..	..	14,000	4·0
Mangolds	3,500	3,200	300	9·4	..	..
Sugar Beet	7,200	6,800	400	5·9	..	..
Cabbage	4,500	5,300	..	..	800	15·1
Rape	10,000	11,000	..	..	1,000	9·1
*Kale	7,000	..	..	.	..	..
Vetches, Tares, Mashlum, etc., for Fodder ..	5,700	6,600	..	..	900	13·6
Small Fruit	9,600	9,400	200	2·1	..	..
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER { For Hay ..	410,000	397,000	13,000	3·3	..	..
RYE-GRASS AND OTHER ROTATION GRASSES AND CLOVER { Not for Hay	1,030,000	1,033,000	..	..	3,000	0·3
TOTAL	1,440,000	1,430,000	10,000	0·7	..	..
OTHER CROPS	5,800	8,700	..	..	2,900	33·3
BARE FALLOW	15,000	13,000	2,000	15·4	..	..

* Not shown separately in 1936.

LIVE STOCK

	No.	*No.*	*No.*	*Per Cent*	*No.*	*Per Cent*
Horses used for Agricultural Purposes (including Mares for Breeding)	108,500	110,000	..	..	1,500	1·4
Unbroken Horses (including Stallions) { One year and above	17,800	17,000	800	4·7	..	..
Unbroken Horses (including Stallions) { Under one year ..	6,900	6,500	400	6·2	..	..
TOTAL	133,200	133,500	..	..	300	0·2
Other Horses	13,600	13,500	100	0·7	..	..
TOTAL OF HORSES . ..	146,800	147,000	..	..	200	0·1
Cows in Milk	365,500	368,500	..	..	3,000	0·8
Cows in Calf, but not in Milk	56,000	55,900	100	0·2	..	..
Heifers in Calf	73,000	70,600	2,400	3·4	..	..
Bulls being used for Service	17,500	17,000	500	2·9	..	..
Other Cattle :—Two years and above ..	194,000	195,500	..	..	1,500	0·8
,, ,, One year and under two ..	318,000	331,500	..	..	13,500	4·1
,, ,, Under one year	270,000	274,000	..	..	4,000	1·5
TOTAL OF CATTLE	1,294,000	1.313,000	..	..	19,000	1·4
Ewes kept for Breeding	3,282.000	3,310,000	..	..	28,000	0·8
Rams to be used for Service	95.500	97,000	..	..	1,500	1·5
Other Sheep :—One year and above	868,000	877,000	..	..	9,000	1·0
,, ,, Under one year	3,258,000	3,273,000	..	..	15,000	0·5
TOTAL OF SHEEP	7,503,500	7,557,000	..	..	53,500	0·7
Sows kept for Breeding	31,000	29,000	2,000	6·9	..	..
Boars being used for Service	3,000	2,800	200	7·1	..	..
Other Pigs	208,000	204,600	3,400	1·7	..	..
TOTAL OF PIGS	242,000	236,400	5,600	2·4	..	..

(*a*) Excluding Mountain and Heath Land used for grazing.

(*b*) The figures for 1937 are subject to revision.

Agricultural Conditions

WARM weather was general during the first two weeks of June, but in the latter part of the month temperatures were lower and winds from northerly points, strong at times, checked growth to some extent. Exceptionally heavy rain fell during the first week of July, particularly in the eastern districts, and for the next fortnight the weather was dull, wet and cold, but it improved towards the end of the month. The absence of sunshine during the earlier weeks delayed the ripening of the crops, grain was partially laid and haymaking was retarded in some districts. August began with a spell of dry, warm weather. Later, broken and changeable weather interfered to some extent with the progress of harvesting operations, but on the whole conditions were favourable for crops and live stock.

Wheat continued to make good progress during June, straw promised to bulk well and in several districts the crop was in ear by the end of the month. Damage by wireworm was evident in Stirling. By the end of July the crop had generally made good growth and was looking vigorous and healthy, although in several districts a spell of warm, bright weather was required to promote growth. In Central Perth there was evidence of ' smut.' By the end of August the cutting of wheat had begun almost everywhere. In Roxburgh the yield is expected to be below the average by 10 per cent and in Upper Moray, Kincardine and Berwick by 5 per cent. In three districts yields are expected to exceed the average by about 10 per cent and in six other districts by 5 per cent. In the remaining wheat-growing areas average yields are anticipated. The total production of wheat this year is forecast at 110,000 tons.

Barley appeared vigorous and healthy in almost all districts at the end of June. In Berwick on poorer land plants were not robust, while in South-East Perth the crop was rather too lush and rank to stand up until ripening. By the end of July plants were strong and healthy and in several areas so well headed that crops were becoming laid. Barley had been cut and partly harvested by the end of August in most districts and the crop was generally satisfactory. Estimates show that in Central Aberdeen the yield will be above the average by about 10 per cent, and in four other districts by about 5 per cent. In other districts where the crop is grown yields are expected to be about average. The total produce is forecast at 77,000 tons.

In most districts oats benefited from favourable weather conditions during June, particularly where sown after lea. On some of the lighter soils, however, the crop was in need of rain, while on the higher ground plants were rather thin in places. During July oats generally made strong and healthy growth although rain had caused some crops to become laid and dry weather was much needed to hasten ripening. By the end of August oats were a good crop in most districts, much progress had been made with cutting, and in some cases part of the crop had been stacked. It is estimated that in two districts this year's production will be below the average by about 5 per cent. In Dunbarton a yield above the average by about 15 per cent is anticipated, and in Lewis there is also a heavy crop. In thirteen districts yields above the normal by about 10 per cent are expected and in thirteen other districts by about 5 per cent above. The total produce is forecast at 680,000 tons.

Beans made vigorous and healthy growth in most districts and by the end of August some crops had already been cut. In Stirling podding was poor and a yield considerably below normal was anticipated; in three districts yields above the average are expected and in the remaining bean-growing districts average yields.

Potatoes made rapid growth during June and at the end of the month reports on the condition of the crop were very favourable. Good progress was made with the digging of early potatoes in South Ayr, while in Wigtown large quantities had been marketed during the month. In most areas vigorous and healthy growth was maintained during July, but in Central Perth disease appeared in many varieties, in Wigtown shaws were in some places affected with disease and in a few other districts blight had occurred. Crops were generally looking well at the end of August. The yield is expected to be below the average in Moray and South-West Banff by from 5 to 10 per cent. In Dumfries a yield 15 per cent above the average is anticipated, in four districts 10 per cent above and in ten districts 5 per cent above. In the remaining districts average yields are anticipated. The total produce is forecast at 950,000 tons.

Turnips and swedes grew well during June and singling was completed in several areas. Some crops in Sutherland and Berwick were badly affected by turnip fly. By the end of July plants in many districts were strong and healthy, but in others progress was backward owing to cold, wet weather. Finger-and-toe was prevalent in several areas. At the end of August crops on the whole were rather below average. Estimates show that in five districts the yield will be 10 per cent above the average, in four districts about 5 per cent above. Average yields are anticipated in eighteen districts, yields below normal by 5 per cent in six and by 15 per cent in another six districts.

Mangolds generally had made favourable progress by the end of July, but during August growth was slow and crops were rather backward owing to lack of sunshine. The yield promises to be about average. Sugar beet made good progress throughout the season, although in a few districts growth had been rather slow. Prospects as regards yield were fairly satisfactory.

The cutting of hay was begun in most districts towards the end of June and in the south-west a fair proportion of the crop was in rick by the end of the month. On the whole, the mixture of clover appeared to be about normal. Crops cut early were secured in good condition, but at a later stage rain seriously interfered with harvesting and much hay was exposed to a period of wet weather. Estimates of the yield of 'seeds' hay show that generally the yield is expected to be above the average. Deficiencies of about 5 per cent are expected in five districts and in one district a deficiency of 15 per cent. Yields exceeding the average by from 5 to 10 per cent are antipicated in twenty districts and by from 15 to 20 per cent in five districts. Estimates for meadow hay generally run on the same lines as those for 'seeds' hay.

Prospects for all classes of fruits were very good at the end of June. In parts of Central Perth considerable damage was caused by frost, while in North-East Fife apples and pears suffered from severe winds. In the Blairgowrie area wet weather during July caused too luxuriant growth of young canes, thus preventing ripening, and yields were expected to be below the average. At the end of August, however, the output was reported to be rather better than at first expected and a heavy crop was gathered in Central Perth. A very good crop of strawberries was obtained in Central Aberdeen. In other fruit-growing districts conditions were fairly good and yields satisfactory.

With grass plentiful and favourable weather conditions, grazing cattle made good progress during June. Flies were less troublesome than usual. Dairy cows also made satisfactory progress, but in Dunbarton there were numerous cases of mastitis among back calving cows and heifers, while mastitis and other udder troubles were prevalent in North Ayr. In a few districts milk yields were rather below the average for the season, but supplies generally were either normal or plentiful. Sheep generally improved in condition and lambs made good progress during June. Maggots were troublesome in a few districts, while in certain areas in the Ochil Hills pastures suffered severely from an invasion of grub. During August foot-rot was prevalent in Kirkcudbright and maggot flies were troublesome, especially among hill sheep, but by the end of the month stocks had on the whole made quite satisfactory progress.

Stocks of bees were generally reported to be in fairly healthy condition and, except in Sutherland, no disease was reported. Yields of honey, however, are generally below the average and the season has been a disappointing one for bee-keepers.

During the month of June many farmers were unable to engage workers for turnip-thinning. During July a shortage of casual workers occurred in most districts and harvest hands were difficult to secure in a number of districts; bracken cutters were scarce in Mid Argyll and dairy workers in Dunbarton were short of requirements. In August casual workers for harvesting were scarce throughout the country, dairy workers were still short of requirements in Dunbarton and North Ayr, while skilled workers were difficult to obtain in South-West Angus, East Perth and Inverness.

STATISTICS

PRICES OF AGRICULTURAL PRODUCE, FEEDING STUFFS AND FERTILISERS IN JUNE, JULY and AUGUST 1937

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	JUNE			JULY			AUGUST		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*	per cwt. *s. d.*
Aberdeen Angus ...	51 4	47 0	42 8	53 11	49 7	45 3	54 1	50 0	44 8
Cross-bred (Shorthorn)	48 6	44 11	36 4	50 9	46 4	38 8	50 10	46 9	37 3
Galloway	51 6	46 4	...	50 11	46 2	...	51 10	47 10	46 6
Ayrshire	50 2	45 2	35 7	50 3	46 9	39 0	51 0	47 0	36 9
Blue Grey	50 5	46 11	43 5	51 1	47 9	44 10	50 9	47 3	43 10
	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
†VEAL CALVES	13½	8	...	13¾	8	...	13	8	...
†SHEEP—	Hoggs under 60 lb. per lb. *d.*	60 lb. and upw'd per lb *d.*	Ewes per lb. *d.*	Hoggs under 60 lb. per lb. *d.*	60 lb. and upw'd per lb. *d.*	Ewes per lb. *d.*	Hoggs under 60 lb. per lb. *d.*	60 lb. and upw'd per lb. *d.*	Ewes per lb. *d.*
Cheviot	14	13	9¼	13¾	13	8¾	13½	12¾	8½
Half-bred	13¾	12¾	8¼	13¼	12¾	8¼	13¼	12¼	8
Blackface	14	13	9	13½	13	9	13½	12¾	8¾
Greyface	14¼	13¼	8¾	13¾	13¼	8¾	13½	12¾	8½
Down Cross	14¼	13¼	8½	13¾	13¼	8½	13¾	13¼	8¼
†PIGS—	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*	per stone *s. d.*
Bacon Pigs	9 8	8 11	...	9 10	9 2	...	10 2	9 4	...
Porkers	10 2	9 4	...	10 4	9 6	...	10 8	9 10	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK: Monthly Averages of Prices (per head) at certain representative Scottish Markets—(*continued*).

DESCRIPTION	JUNE			JULY			AUGUST		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK:—									
CATTLE—									
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	17 2	13 14	11 15	16 16	14 0	...	17 8	14 12	...
Two-year-olds ...	21 9	17 12	14 5	20 10	17 6	...	21 10	18 5	...
Cross-bred (Shorthorn)									
Yearlings	16 6	13 0	11 13	15 14	12 19	10 18	16 0	13 9	...
Two-year-olds ...	20 8	17 3	15 0	20 19	18 1	16 14	21 0	18 8	16 13
Galloway:									
Yearlings	14 3	11 17	..	13 3	11 3	...	13 0	11 3	...
Two-year-olds ...	19 5	15 15	...	...	16 10	...	18 18	...	...
Ayrshire:									
Yearlings	13 11	11 9	...	13 9	11 2	...	..	...	..
Two-year-olds ...	16 9	...	...	16 3	...	...	...	...	...
Blue Grey:									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Highland:									
Yearlings	10 0	8 17	7 0	...	...	...	...	...	...
Two-year-olds ...	12 15	11 17	10 0	...	...	...	...	...	...
Three-year olds ...	14 18	12 14	...	...	...	...	..	...	...
DAIRY COWS—									
Ayrshire:									
In Milk	28 11	21 8	16 16	28 4	22 3	17 19	28 1	21 3	16 12
Calvers	29 1	22 9	16 19	28 15	22 10	17 8	29 11	21 13	16 12
Shorthorn Cross:									
In Milk	27 10	19 17	17 14	27 17	20 15	19 12	27 9	20 10	17 16
Calvers	27 12	19 5	17 3	28 1	19 14	16 16	29 4	20 1	17 9
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	. .	...	...	...	...	...	50 0	...	...
Half-bred Hoggs ...	63 4	50 3	..	...	...	...	...	...	...
Blackface Hoggs ...	43 2	34 4	34 0	...	...	...	...	...	...
Greyface Hoggs ...	57 1	47 4	...	...	41 6	...	53 6	45 7	...
Down Cross Hoggs	...	...	...	...	...	...	...	...	...
PIGS—									
(6 to 10 weeks old)	34 8	24 6	...	34 0	24 7	...	33 11	24 3	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	QUALITY	JUNE			JULY			AUGUST		
		Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow	Dundee	Edinburgh	Glasgow
BEEF:—		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
Home-fed—										
Bullock or Heifer ...	1	8⅜	8⅛	9⅜	9	8⅝	9⅝	9	8¾	9⅞
	2	7¾	...	8⅝	8½	...	8⅞	8½	..	9⅜
Bull	1	6½	6¼	5¾	6⅞	6⅛	5¾	6⅝	6⅜	5¾
	2	6⅛	...	5¼	5⅞	...	5¼	5⅝	...	5¼
Cow	1	6½	6	5¾	6⅞	5¾	5¾	6⅝	5⅝	5¾
	2	6	...	5⅛	5⅞	...	5	5⅝	...	5
Irish—										
Bullock or Heifer ...	1	...	...	8¼	...	...	8¾	...	...	8⅞
	2	...	...	7⅞	...	...	8¼	...	...	8⅜
Argentine Frozen—										
Hind Quarters ...	1	...	5½	...	...	4¾	...	...	4⅞	...
	2	...	...	...	...	4½	...	...	4⅛	...
Fore ,, ..	1	...	4⅞	...	...	4⅛	...	..	3¾	...
	2	...	...	...	...	4	...	...	3¼	...
Argentine Chilled—										
Hind Quarters ...	1	7⅛	7¼	6½	7¼	7¼	6¼	7½	8	6¾
	2	...	5⅞	...	...	6½	...	...	7¼	...
Fore ,, ...	1	5	5⅛	4⅞	4¾	4⅞	4½	4⅝	4¾	4½
	2	...	4¾	4½	...	4⅝	...	...	4⅜	4¼
Australian Frozen—										
Hind Quarters ...	1	5⅛	...	5½	4⅝	...	5⅛	4¼	...	4⅞
	2	...	...	...	..	..	...	...	...	...
Crops	1	4⅞	...	5¼	4⅛	...	4⅝	4⅛	...	4
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	5⅛	...	5½	4⅝	...	5⅛	4½	.	5
	2	...	...	...	...	...	...	...	...	..
Fore ,, ...	1	4¾	...	5	4⅛	..	4⅜	3¾	...	4
	2	...	...	...	...	...	...	..	...	...
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	13⅝	13⅛	13½	13½	12⅜	13¾	13	11¼	12¼
	60 lb. & over	12⅝	...	12¾	12½	...	13	12	...	11⅛
,, Cross ...	under 60 lb.	13⅝	13⅛	13½	13	12⅜	13¾	13	11¼	12¼
	60 lb. & over	12⅝	...	12¾	12½	...	13	12	...	11⅛
Ewes, Cheviot ...	1	...	7⅞	9½	...	7¾	9⅛	...	7¼	8⅜
	2	...	...	9¼	...	...	8⅝	...	...	7¾
,, Blackface ...	1	9⅝	7⅞	9½	9	7¾	9⅛	8¾	7¼	8⅝
	2	8¾	...	9¼	8½	...	8⅝	8¼	...	7¾
,, Cross	1	8	7⅞	8	6¾	7¾	7⅞	6¼	7¼	7⅜
	2	6⅝	...	7½	6	...	7	5¾	...	6¾
Australian Frozen ...	1	...	5¼	4½	...	5¼	4½	...	6	4½
	2	...	4¾	...	...	4¾	...	...	4⅝	...
Argentine ,, ...	1	...	...	4½	...	...	4½	...	...	4½
	2	...	...	...	...	...	...	...	...	...
New Zealand ,, ...	1	...	...	5¼	...	5¼	5¼	...	...	5¼
	2	...	...	4½	...	4¾	4½	...	...	4¼
LAMB:—										
Home-fed	1	17	15	14¾	15	13⅜	14⅝	14½	13⅛	13⅛
	2	...	...	13⅝	14	...	14⅛	13½	...	12¼
Australian Frozen ...	1	...	..	6⅝	...	...	6¾	...	...	6¾
	2	...	...	..	...	...	...	...	..	...
Argentine ,, ...	1	...	...	6¾	...	...	6¾	...	...	6¾
	2	...	...	...	...	..	...	...	...	...
New Zealand ,, ...	1	...	7¾	7¼	...	7⅞	7¼	...	8⅛	7⅜
	2	...	6½	..	...	3¾	...	...	7½	...
		per cwt. *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*	*per cwt.* *s. d.*
PORK:—										
Home-fed	1	74 8	75 7	77 6	70 0	78 2	77 0	70 0	74 8	77 0
	2	56 0	...	72 4	37 4	...	72 4	37 4	...	72 4
Imported	1	...	...	59 6	...	...	59 6	...	...	59 6

Kilmarnock, Lanarkshire and Glasgow.

Description	Weight per 120	Quality	June	July	August
	lb.		s. d.	s. d.	s. d.
Aberdeen—					
Country (ungraded) per doz.	...	1	0 11¾	1 2¾	1 3¾
	...	2	0 11¼	1 2¼	1 2¾
Kilmarnock—					
Country (ungraded) per doz.	...	1	1 2¼	1 5¾	1 5½
Lanarkshire—					
Country, "Standard" per doz.	...	1	1 3½	1 7	1 7½
Glasgow—					
Unstamped Scottish per doz.	...	1	1 3	1 6¾	1 6¼
National Mark—					
"Specials" ... ,,	...	...	1 3	1 6¼	1 7
"Standards" ... ,,	...	...	1 2	1 5½	1 6¾
"Mediums" ... ,,	...	...	1 0	1 3½	1 5¼
Ungraded ... ,,	...	1	1 0¾	1 3¾	1 4¾
"Specials" ... per 120	...	...	12 4	15 3	16 0
"Standards" ... ,,	...	...	11 6	14 4	15 2
"Mediums" ... ,,	...	...	10 1	12 10	13 9
Ungraded ... ,,	...	1	10 7	13 0	14 0
Northern Ireland ,,	17	...	12 0	15 0	15 7
,, ,,	15½	...	11 1	14 1	14 8
,, ,,	14	..	9 7	12 8	13 4
,, (Duck) ,,	...	1	8 11	10 8	11 1
Irish Free State ... ,,	16	...	9 1	12 2	13 4
,, ... ,,	15	...	8 6	11 3	12 10
,, ... ,,	14	...	7 10	10 2	11 8
,, (Duck) ,,	...	1	8 4	9 11	10 3
Danish ... ... ,,	17	...	10 1	...	13 0
,, ... ,,	15	...	9 0	11 6	12 0
,, ... ,,	14	...	8 6	10 6	11 2
Finnish ... ... ,,	15½	...	...	...	11 0
,, ... ,,	14	..	...	...	10 5

(Compiled from returns received from the Department's Market Reporters)

[illegible]. Monthly Average Wholesale Prices (per cwt.) at Glasgow.

Description	Quality	June	July	August
		s. d.	s. d.	s. d.
Butter—Scot. Creamery ..	1	112 0	118 3	125 6
,, ,, ,, (unsalted)	1	112 0	118 3	125 6
Irish Creamery	1	112 10	116 9	124 0
Australian	1	111 9	116 9	121 6
New Zealand	1	113 0	117 3	123 0
Danish	1	118 10	124 3	129 6
,, (unsalted)	1	...	...	...
Dutch	1	109 2	113 9	117 0
Latvian	1	110 0	114 9	118 6
Swedish	1	114 0	119 0	124 6
Cheese—Cheddar	1	88 0	88 0	88 0
,, ,, Loaf	1	84 5	79 0	80 0
Dunlop	1	86 0	86 0	86 0
Canadian	1	80 0	82 0	82 0
New Zealand (Coloured) ...	1	76 2	75 0	73 6
,, (White)	1	76 2	75 0	73 6
*Farmhouse Cheese—				
Coloured Cheddar	...	67 11	69 0	70 3
White Cheddar	...	67 11	70 0	72 8
Dunlop	...	67 11	69 8	72 2
Cheshire ... ... per lb.	. .	0 6¼	0 7	0 7½
*Factory Cheese—				
Coloured Cheddar	...	68 5	70 3	69 8
White Cheddar	...	70 0	70 0	..
Dunlop	.	69 3	70 6	74 6
Hams—Irish (Smoked)	1	172 0	172 0	172 0
	2	157 0	157 0	152 6
,, (Boneless)	1	148 0	148 0	148 0
American (Short Cut, Green) ..	1	100 10	109 3	116 0
Bacon—Ayrshire (Rolled) ...	1	118 2	123 8	135 4
English Wiltshire (Green) ...	1	94 7	100 6	107 6
,, (Dried or Smoked ...	1	102 7	108 6	115 6
Irish (Green, Wiltshire Style) ...	1	87 7	94 0	103 0
,, (Dried or Smoked) ...	1	95 7	102 0	111 0
	2	93 7	100 0	109 3
,,(Long Clear, rolled with skin on)	1	107 7	114 0	123 0
	2	95 7	107 0	121 0
Canadian Sides (Green) ...	1	84 10	93 0	102 0
Danish Sides	1	101 10	107 6	115 6
Dutch Sides (Green, Wiltshire Style)	1	101 5	109 9	119 0
Lard—American	1	74 2	71 3	71 0

* Average Prices compiled from Returns received from the Scottish Milk Marketing Board, Glasgow.

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter)

DESCRIPTION		QUALITY	JUNE	JULY	AUGUST
FRUIT:—					
Apples—	per		s. d.	s. d.	s. d.
American	case.*	1	...	...	10 8
Australian	,, *	1	10 8	11 8	...
New Zealand	,, *	1	...	12 2	11 11
Pears—					
Australian	case.*	1	14 2	18 0	...
Californian	,, *	1	...	..	19 2
Blackberries	lb.	1	...	...	0 5¾
Currants—					
Black	,,	1	...	0 6¼	0 5¾
Red	,,	1	...	0 4¾	0 4¼
Gooseberries	,,	1	0 3	0 2¼	0 2
Raspberries	,,	1	...	0 5¾	0 5¾
Strawberries—					
Scottish	,,	1	0 8	0 7½	0 8¼
English	,,	1	0 10½	0 7½	...
Cherries	,,	1	0 8¾	0 9¼	..
Plums—					
Egg	,,	1	...	...	0 1½
Czar	,,	1	...	...	0 2¾
Victoria	,,	1	...	...	0 4½
VEGETABLES:—					
Beet	cwt.		5 0	†4 6	†3 11
Cabbage—					
Coleworts	dozen.		1 1	1 3	1 3
Scottish	,,		2 0	2 0	1 8
Carrots—					
English	cwt.		7 2	15 0	11 9
Dutch	,,		†6 4	15 6	10 0
Cauliflowers—					
British	dozen.		4 8	4 3	3 5
Dutch	,,		4 2	...	..
Celery	bunch.		...	...	2 9
Cucumbers	dozen.		6 1	5 6	4 9
Leeks	dozen bunches.		4 3	...	4 0
Lettuce—					
Cos	dozen.		...	1 3	1 3
Cabbage	,,		2 0	1 5	1 5
Onions—					
Spring	bunch.		0 5¼	0 5¼	0 4½
Egyptian	cwt.		6 8	8 5	7 8
Parsley	,,		15 2	50 8	32 0
Parsnips	,,		6 6	...	12 0
Peas	,,		**6 2	18 0	12 0
Radishes	dozen bunches.		1 1	1 2	1 5
Rhubarb	cwt.		4 2	5 0	6 0
Spinach	stone.		3 0	3 0	2 8
Tomatoes—					
Scottish	lb.		0 9¼	0 6	0 5¾
Channel Islands	,,		0 7¾	0 5¼	0 4¾
Dutch	,,		0 7¾	0 6	0 4
Turnips	dozen bunches.		3 4	2 6	‡4 8
Vegetable Marrow	dozen.		...	6 0	5 0

* 40 lb. (approx.). † dozen bunches. ** per bag 20 lb. ‡ per cwt.

POTATOES: Monthly Average Wholesale Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	JUNE					
		FIRST EARLIES	SECOND EARLIES	LATE VARIETIES			
				RED SOILS		OTHER SOILS	
				Golden Wonder	Other	Golden Wonder	Other
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Aberdeen ...	1	14 10 0	...	...	...	7 10 8	5 12 6
Dundee ...	1	11 10 0	...	...	...	8 0 0	6 13 5
Edinburgh ..	1	10 0 0	.	...	8 0 0	...	7 13 4
Glasgow ..	1	11 15 0	...	...	...	8 12 0	7 4 0
		JULY					
Aberdeen ...	1	11 12 11	...	..	...	...	...
Dundee ...	1	7 18 9	..	...	...	...	...
Edinburgh ...	1	7 8 4	...	...	...	...	...
Glasgow ..	1	7 13 9	...	...	. .	...	...
		AUGUST					
Aberdeen ...	1	...	5 16 3	...	.	...	...
Dundee ...	1	4 4 5	5 6 8	...	...	...	...
Edinburgh ...	1	3 15 0	4 5 0	..	...	...	...
Glasgow ...	1	3 15 0	..	...	...	...	..

ROOTS, HAY, STRAW AND MOSS LITTER: Monthly Average Prices (per ton) at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters)

MARKET	Quality	JUNE								
		ROOTS			HAY		STRAW			MOSS LITTER
		Carrots	Yellow Turnips	Swedes	Rye Grass and Clover	Timothy	Wheat	Barley	Oat	
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
*Aberdeen ...	1	...	...	...	94 0	...	..	...	42 6	...
†Dundee ...	1	...	...	...	145 0*a* 130 0*b*	...	98 0	...	100 0	...
‖Edinburgh ...	1	...	...	...	117 0*a* 117 0*b*	...	62 0	60 0	64 0	...
*a*Glasgow ...	1	...	...	...	114 0	119 0	68 0	...	69 0	45 0*c*
		JULY								
*Aberdeen ...	1	...	...	...	91 3	...	...	...	36 3	...
†Dundee ...	1	...	...	...	142 6*a* 130 0*b*	...	98 9	...	98 9	...
‖Edinburgh ...	1	...	...	...	103 2*a* 103 2*b*	...	60 0	60 0	60 0	...
*a*Glasgow ...	1	...	...	...	110 0	115 0	60 0	...	65 0	41 3*c*
		AUGUST								
*Aberdeen ...	1	...	...	...	78 9	. .	...	...	32 6	...
†Dundee ...	1	...	...	...	137 6*a* 71 3*d*	...	100 0	...	100 0	...
‖Edinburgh ...	1	...	...	...	87 6*a* 87 6*b*	...	65 0	60 0	65 0	...
*a*Glasgow ...	1	...	...	...	110 0	115 0	60 0	...	65 0	40 0*c*

* Ex farm, loose.
† Baled straw, delivered in town.
‖ Bunched or baled straw, delivered.

a Baled and delivered. *b* Delivered, loose.
c Home moss litter, in 1¼-cwt. bales.
d Delivered loose (new crop).

FEEDING STUFFS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	JUNE		JULY		AUGUST	
	Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
Linseed Cake—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Home	9 8 9	9 6 0	9 7 6	9 5 0	9 11 3	9 8 9
Foreign	9 3 3	...	9 4 5	...	9 7 10	...
Decort. Cotton Cake ...	8 16 3	8 10 0	8 18 5	8 12 6	8 19 8	8 15 0
Undecort. Cotton Cake—						
Egyptian (Home manufactured)	6 7 0	6 6 0	6 4 1	6 3 9	6 5 0	6 5 0
Groundnut Cake, undecort.—						
(40% Oil and Albuminoids)	...	8 9 5	...	7 15 0	...	7 18 2
(50% ,, ,,)	8 1 11	...	8 6 3	...	8 8 5	...
(54% ,, ,,)	8 5 0	...	8 12 6	...	8 10 11	...
Maize Germ Cake (Home mfd.)	8 5 0	...	8 6 7	...	8 12 10	...
Rice Meal	6 19 0	...	6 18 5	...	7 0 11	...
Maize Germ Meal	7 6 9	...	7 4 7	...	7 2 10	...
Bean Meal	9 0 6	8 15 0	9 13 5	9 0 0	10 1 7	9 7 6
Fish Meal	14 17 0	14 18 0	15 10 8	15 7 6	15 5 8	15 5 8
Maize Meal –						
(Home manufactured) ...	7 13 9	7 7 0	7 13 7	7 10 0	7 14 5	7 11 3
Barley Meal	10 2 9	10 0 0	10 4 1	9 18 9	10 6 3	10 0 0
Locust Bean Meal	8 1 0	7 15 0	7 15 0	7 15 0	7 12 6	7 15 0
Locust Beans (Kibbled and Stoned)	7 2 6	6 15 0	6 19 1	6 13 9	7 0 11	6 13 9
Maize Gluten Feed (Paisley)	7 10 3	...	7 5 0	...	7 5 8	...
Maize—						
Plate	6 18 2	6 11 0	6 18 2	6 16 3	6 18 2	6 16 3
Oats—						
Home	8 14 0	8 12 6	8 14 5	8 11 11	9 3 9	8 16 3
Canadian	8 0 0	...	8 1 3	...	8 11 11	...
Barley—						
Imported	9 5 6	8 12 0	9 6 7	9 2 6	9 8 9	9 4 2
Malt Culms	6 3 6	5 5 0	6 6 3	5 7 6	6 10 0	5 10 0
Brewers' Grains (dried)	6 15 3	6 0 0	6 15 0	6 0 0	6 14 1	5 18 9
Distillers' Malt Grains (dried)	7 7 0	...	7 7 6	...	7 5 8	...
Distillers' Mixed Grains (dried)	7 4 6	6 15 0	7 8 4	7 5 0	7 10 0	7 7 6
Wheat—						
Home	10 3 9	9 19 6	10 0 0	9 19 5	10 6 11	9 18 9
,, (Poultry)	9 3 0	...	9 18 2	...	9 17 6	...
Middlings (Fine Thirds or Parings)	8 12 9	8 3 0	8 17 2	8 10 0	9 0 8	8 15 0
Sharps (Common Thirds)	7 10 0	7 5 0	7 14 8	7 9 5	7 19 5	7 13 9
Bran (Medium)	7 0 0	7 0 0	7 7 2	7 4 5	7 11 7	7 10 0
,, (Broad)	7 9 3	7 8 0	7 15 0	7 12 6	7 19 5	7 19 5
Feeding Treacle	5 12 6	6 5 0	5 12 6	6 5 0	5 12 6	6 5 0
Crushed Linseed	18 4 0	17 10 0	18 2 6	17 13 4	18 10 0	17 10 0
Beans—						
China	8 3 2	7 16 6	8 15 8	8 6 3	9 4 9	8 17 6
Rangoon (White)	7 5 0	...	7 9 7	...	8 5 0	...
Peas—						
Karachi (White)	10 15 0	...	10 5 0	...	10 3 6	...
Sugar-Beet Pulp (English)	7 5 0	...	7 5 0	...	7 5 0	...
,, ,, ,, (Irish) ...	7 5 0	...	7 5 0	...	7 5 0	...
Linseed Oil, per gall. ...	0 4 3	...	0 4 3	...	0 4 3	...

FERTILISERS: Monthly Average Prices (per ton) at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters)

DESCRIPTION	Guaranteed Analysis	JUNE		JULY		AUGUST	
		Glasgow	Leith	Glasgow	Leith	Glasgow	Leith
	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Nitrate of Soda*	N. 15.5	7 12 6	7 12 6	7 12 6	7 12 6	7 18 2	7 12 6
Sulphate of Ammonia (Neutral and Granular)* ...	N. 20.6	7 5 0	7 5 0	7 5 0	7 5 0	7 6 6	7 5 0
Calcium Cyanamide†	N. 20.6	7 5 0	7 3 9	7 5 0	7 3 9	7 5 8	7 3 9
Nitrochalk* ...	N. 15.5	7 5 0	7 5 0	7 5 0	7 5 0	7 9 0	7 5 0
Superphosphate ...	P.A. 13.7	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0
,, ...	,, 16.0	3 1 0	3 1 0	3 1 0	3 1 0	3 1 0	3 1 0
,, ...	,, 18.3	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0
Ground Mineral Phosphate § ...	P.A. 26	2 15 0	2 12 6	2 15 0	2 12 6	2 16 11	2 12 6
,, ,, ,, § ...	,, 34	3 15 0	...	3 15 0	...	3 16 11	...
Potassic Mineral Phosphate	P.A. 18 Pot. 10	3 16 3	.	3 16 3	..	3 18 2	...
,, ,, ,,	P.A. 20 Pot. 7.5	3 11 3	...	3 11 3	...	3 13 2	...
Kainit (in bags) ...	Pot. 14	3 1 3	3 0 0	3 1 3	3 0 0	3 1 3	3 0 0
Potash Salts ...	Pot. 20	4 2 6	4 0 0	4 2 6	4 0 0	4 2 6	4 0 0
,, ,, ...	,, 30	5 1 3	4 15 0	5 1 3	4 15 0	5 3 9	4 15 0
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	8 2 6	7 15 0	8 2 6	7 15 0	8 7 6	7 15 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48.6	9 15 0	9 7 6	9 15 0	9 7 6	10 0 0	9 7 6
Steamed Bone Flour	N.O. 0.8 P.A. 28	5 7 6	5 5 0	5 11 3	5 5 0	5 12 6	5 5 0
Bone Meal (Indian)	N. 4 P.A. 20	6 12 6	6 10 0	7 1 11	6 10 0	7 5 0	6 10 0
Basic Slag‡ ...	P.A. 12	2 7 6	1 3 3	2 7 6	1 3 3	2 7 6	1 3 3
,, ,, ...	,, 13	2 9 6	1 5 6	2 9 6	1 5 6	2 9 6	1 5 6
,, ,, ...	,, 14	2 11 6	1 7 6	2 11 6	1 7 6	2 11 6	1 7 6
,, ,, ...	,, 15	...	1 10 6	...	1 10 6	...	1 10 6
,, ,, ...	,, 15¾	...	1 12 6	...	1 12 6	...	1 12 6
,, ,, ...	,, 16½	...	1 15 6	...	1 15 6	...	1 15 6

Abbreviations:—N. = Nitrogen; P.A. = Phosphoric Acid; Pot. = Potash.

* Carriage paid, in 6-ton lots. † Carriage paid, in 4-ton lots.

§ Fine grist, 90 per cent fineness through prescribed sieve.

‡ Basic Slag: At Glasgow—80 per cent citric soluble and 80 per cent fineness; F.o.r., in 6-ton lots.

At Leith—80 per cent fineness, no guarantee of citric solubility, *ex* Middlesborough, in wagon loads, carriage varies by from 15s. to 17s. per ton.

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INDEX TO VOL. XX—1937

Agriculture and public health 1

Agriculture Act, 1937 383

Agriculture Bill 289

Agriculture, early Scottish 241

Agriculture, General Assembly of the International Institute of 72

Agriculture, national plan for 6

Agricultural colleges, notes from 57, 186

Agricultural conditions 96, 210, 313, 398

Agricultural economics, prize essays in 195

Agricultural returns and statistics:
  Abstract of agricultural returns, 1936 117
  Acreage under each variety of potatoes in 1936 91
  Agricultural returns, 1936 (Abstract) 94
  Agricultural returns, 1937 (Preliminary statement) 394
  Estimates of the produce of crops 99
  Prices of dead meat 111, 220, 325, 403
  Prices of eggs 112, 221, 326, 404
  Prices of fat stock 109, 218, 323, 401
  Prices of feeding stuffs 115, 224, 329, 407
  Prices of fertilisers 116, 225, 330, 408
  Prices of fruit and vegetables 113, 222, 327, 405
  Prices of potatoes 114, 223, 328, 406
  Prices of provisions 112, 221, 326, 404
  Prices of roots, hay, straw, moss litter 114, 223, 328, 406
  Prices of store stock 110, 219, 324, 402
  Winter census of cattle, sheep and pigs 208

Agricultural scholarships for the sons and daughters of agricultural workers and others 90

Agricultural scholarships, post-graduate and refresher course grants 194

Agricultural Wages (Regulation) (Scotland) Act, 1937 380

Animal breeding:
  Aberdeen-Angus under conditions in U.S.S.R. (*U.S.S.R.*) 213
  Beef and dual purpose cattle breeding (*U.S.A.*) 102
  Breeding for milk yield and uniformity 26
  Carcase quality in the bacon hog, some observations on 317
  Improving horses and mules (*U.S.A.*) 103
  Inbreeding in the white leghorn (*U.S.A.*) 214
  Keeping the proven sire 287
  Lethal nature of flightlessness in the fowl (*U.S.A.*) 318
  Mortality in chick embryos (*U.S.A.*) 214

Animal breeding—*continued.*
  New lethal factor in the horse (*U.S.A.*) 318
  Pig production, study of certain breeding practices in 316
  Position of the chick at hatching (*U.S.A.*) 214
  Producing better dairy cattle (*U.S.A.*) 103
  Production of high-grade pigs 104
  Soft pork (*U.S.A.*) 103
  Some grading results at an eastern counties bacon factory 104
  Superior breeding stock in poultry 103
  Swine—some current breeding problems (*U.S.A.*) 103
  Trek of the golden fleece (*U.S.A.*) 213

Animal health, Studentships for research in 91, 386

Animal nutrition:
  Bone meal in the feeding of poultry (*Poland*) 107
  Comparative value of soya beans and of meat meal in poultry feeding (*Poland*) 107
  Comparison of management methods for chicks, layers and breeding hens (*U.S.A.*) 318
  Damaged potato silage (*Germany*) 319
  Effect of A.I.V. silage on butter quality (*Germany*) 106
  Effect of feeds on quality and palatability of lamb (*U.S.A.*) 319
  Effect of nutrition on sexual function (*U.S.S.R.*) 104
  Effect of size and type of ewe on efficiency of production (*U.S.A.*) 106
  Effect of variations in feeding on dairy cows yielding milk of poor quality 106
  Experiment in the substitution of ammonium bicarbonate for foreign oilcake protein in feeding milk cows on beet silage (*Germany*) 105
  Fishy flavour of milk caused by feeding beet by-products 106
  Fresh milk waste as a fodder (*Germany*) 318
  Green sprouted forage for feeding purposes 104
  Interim report of pig feeding experiment conducted on the Cambridge University farm during 1935 107
  Locust meal as a poultry feed (*U.S.A.*) 318
  Nutritive value of artificially dried grass and its effect on quality of milk 106
  Nutritive value of proteins for milk production 105
  Potatoes in the food rations of goslings 107
  Protein requirements of fat pigs (*Germany*) 318
  Quantities of grass that dairy cows will graze (*U.S.A.*) 105
  Use of whey in pig breeding (*Germany*) 318
  Value of the mallow as fodder (*Germany*) 319

Biological notes for 1936 63

Blowfly, some results of trapping the sheep 123

" Boots " for sheep 91

Braid, K. W., M.A., B.Sc., and Tervet, I. W., B.Sc.: Certain botanical aspects of dying-out of heather 365

Breeding for milk yield and uniformity 26

Caie, J. M., M.A., B.L., B.Sc. (Agr.): State intervention in Agriculture 331

Certain botanical aspects of dying-out of heather 365

Chemical control of the sheep maggot fly 227

Cleaning dirty land to produce soil fertility 41

Cohen, Ruth, M.A.: Variation in retail milk prices between different areas . 273

Conacher, H. M.: Nature, science and labour in agriculture 353

Crops and seeds:
- Actual problems of potato breeding (*Holland*) 315
- Breeding for resistance to late blight in the potato (*U.S.A.*) 212
- Cleaning and handling of barley 315
- Grass studies, I—Influence of constant self-pollination on the development and yield of timothy 213
- Investigations on a rot of swedes in 1934 caused by bacterial attack (*Denmark*) 102
- Observations relative to pasture seed mixtures (*New Zealand*) . . 212
- Pea mosaic: Its symptoms, economic significance and preventive treatment (*New Zealand*) 315
- Problem of potato breeding (*U.S.A.*) 101

Dairying:
- Alfalfa-molasses silage vs. alfalfa hay as a roughage for lactating dairy cows (*U.S.A.*) 320
- Biennial review of the genetics of dairy cattle 320
- Certified milk as a source of vitamin C 108
- Churn cleaning methods (*U.S.A.*) 215
- Cleaning dairy equipment (*U.S.A.*) 215
- Effect of variations in feeding on dairy cows yielding milk of poor quality 106
- Eleventh world's dairy congress, Berlin, 1937 383
- Emery flavour in milk (*Germany*) 215
- Experiment in chopping alfalfa hay at time of storage (*U.S.A.*) . . 320
- Homogenisation as a preventive of oxidised flavour in milk . . . 320
- Improving the flavour of market milk by clarification (*Germany*) . . 320
- Removal of sediment from milk 108
- Size as a factor in performance (*Germany*) 320
- Tested sires and dams of the Jersey breed (*U.S.A.*) 319
- Variations in the vitamin C content of milk (*U.S.A.*) 320
- Vitamin C in pasteurised milk 107

Denmark:
- Investigations on a rot of swedes in 1934 caused by bacterial attack . . 102

Early Scottish agriculture 241

Economics, prize essays in agricultural 195

Economists, Fourth International Conference of Agricultural, St. Andrews, 1936 74

Eleventh World's Dairy Congress, Berlin, 1937 383

Encouragement of better plants in pasture 347

Ewe hoggs, wintering of 166

Farm wages in Scotland 298

Fenton, E. Wyllie, M.A., D.Sc.: Biological notes for 1936 63

Finland:
- Influence of types of rocks on the plant food content of natural soils . 217

Flax-growing in Scotland—I Cultivation and harvesting 150
- II Costs and returns 157

Fourth International Conference of Agricultural Economists, St. Andrews, 1936 . 74

Fourth International Grassland Congress 193

Fraser, A. H. H., B.Sc., M.D.: Wintering of ewe hoggs 166

General Assembly of the International Institute of Agriculture . . . 72

Germany:
  Boron-superphosphate as a means of combating crown and dry rot in beet root 217
  Damaged potato silage 319
  Effect of A.I.V. silage on butter quality 106
  Effect of potash fertilisers in increasing potato yields 322
  Experiment in the substitution of ammonium bicarbonate for foreign oilcake protein in feeding milk cows on beet silage 105
  Fresh milk waste as a fodder 318
  Improving the flavour of market milk by clarification 320
  Influence of potash deficiency on the development of sugar beet . . 322
  Influence of wart disease on the metabolic processes involving magnesium in the potato tuber 216
  Protein requirements of fat pigs 318
  Size as a factor in performance 320
  Use of whey in pig breeding 318
  Value of the mallow as fodder 319

Grass and money 31

Grassland Congress, Fourth International 193

Grazing lands, improvement of 173

Hall, Sir Daniel, K.C.B., F.R.S.: National plan for agriculture . . . 6

Harbours, Piers and Ferries (Scotland) Act, 1937 294

Holland:
  Actual problems of potato breeding 315

Howells, Dudley V., Agric. Dip. (U.C.W.), and Vick, J. O. C., A.R.C.S., B.Sc., D.I.C., A.Inst.P.: Some recent work on the preservation of perishable foodstuffs 135

Huskless oats 161

Improvement of grass land by ploughing up and sowing out direct . . . 251

Increased meat production 10

Increased production of milk 15

Irradiation of plants with neon light 192

Jones, Martin, M.Sc.: The encouragement of better plants in pasture . . 347

Kay, Professor H. D.: Increased production of milk 15

Keeping the proven sire 287

Kirkwood, John, B.Sc., N.D.A., N.D.D.: The improvement of grass land by ploughing up and sowing out direct 251

Labour on Scottish farms 94

Lime on the soil, effects of 258

Lungworms in pigs 373

M'Callum, Alex., O.B.E., M.A., LL.B.: Early Scottish agriculture . . 241

M'Candlish, A. C., B.Sc., Ph.D., and Struthers, J. P., B.Sc., N.D.A.: Keeping the proven sire 287

Macleod, A., B.Sc., and Ogg, W. G., M.A., B.Sc., Ph.D.: Reclamation and cultivation of peat land in Lewis 179

Maggot fly, chemical control of the sheep 227

McIntosh, T. P., B.Sc., Ph.D.: Potato notes 67

Marrow-stem kale 191

Meat, increased production of 10

Milk, increased production of 15

Milk, Report of the Reorganisation Commission for, for Great Britain . . 70

Milk yield and uniformity, breeding for 26

Moore, Walter, B.Sc., B.Sc.(Agr.): Chemical control of the sheep maggot fly 227

Morrison, G. D.: Some results of trapping the sheep blowfly 123

National nutrition and British agriculture 1

National plan for agriculture 6

Nature, science and labour in agriculture 353

New Zealand:
- Observations relative to pasture seed mixtures 212
- Pea mosaic: Its symptoms, economic significance and preventive treatment 315

Oats, huskless 161

Ogg, W. G., M.A., B.Sc., Ph.D., and Macleod, A., B.Sc.: Reclamation and cultivation of peat land in Lewis 179

Orr, John: Grass and money 31

Orr, Sir John, D.S.O., M.C., M.A., M.D., M.Sc., F.R.S.: Agriculture and public health 1

Out-wintering of cattle and winter's pasture 378

Peat land in Lewis, reclamation and cultivation of 179

Poland:
- Bone meal in the feeding of poultry 107
- Comparative value of soya beans and of meat meal in poultry feeding . 107

Potatoes:
- Actual problems of potato breeding (*Holland*) 315
- Breeding for resistance to late blight (*U.S.A.*) 212
- Influence of wart disease on the metabolic processes involving magnesium in the potato tuber (*Germany*) 216
- Potato eelworm, observations on 264
- Potato notes 67
- Problem of causes of blackening in cooked potatoes (*U.S.A.*) . . . 316
- Problem of potato breeding (*U.S.A.*) 101

Poultry:
- Bone meal in the feeding of poultry (*Poland*) 107
- Comparative value of soya beans and of meat meal in poultry feeding (*Poland*) 107

Poultry—*continued.*
  Comparison of management methods for chicks, layers and breeding hens (*U.S.A.*) 318
  Inbreeding in the white leghorn (*U.S.A.*) 214
  Lethal nature of flightlessness in the fowl (*U.S.A.*) 318
  Locust meal as a poultry feed (*U.S.A.*) 318
  Mortality in chick embryos (*U.S.A.*) 214
  Position of the chick at hatching (*U.S.A.*) 214
  Potatoes in the food ration of goslings 107
  Poultry Congress, Sixth World's: Leipzig 1936 77
  Starting a poultry small holding 283
  Superior breeding stock in poultry (*U.S.A.*) 103

Preservation of perishable foodstuffs, some recent work on the . . . 135

Reclamation and cultivation of peat land in Lewis 179

Reorganisation Commission for milk for Great Britain, Report of the . . 70

Reviews 80, 196, 301, 386

Robb, Wm., N.D.A., F.R.S.E.: Huskless oats 161

Robertson, D., Ph.D., B.Sc.(Agr.), N.D.A.:
  Observations on the potato eelworm 264
  Lungworms in pigs 373

Rural housing in Scotland, Report on 290

Sandison, I. E. M.: Out-wintering of cattle and winter's pasture . . . 378

Scarlett, R. L., C.D.A.: Cleaning dirty land to produce soil fertility . . 41

Seed testing and plant registration 46

Sheep Stocks Valuation (Scotland) Act, 1937 295

Sixth World's Poultry Congress, Leipzig, 1936 77

Smith, A. D. Buchanan, M.A., M.Sc., F.R.S.E.: Breeding for milk yield and uniformity 26

Soils:
  Availability of phosphate rocks in soils of varying degrees of acidity (*U.S.A.*) 322
  Base status of Scottish soils, I—The effects of lime on five typical soils from north-east Scotland 216
  Boron-superphosphate as a means of combating crown and dry rot in beet root (*Germany*) 217
  Comparison between the effects of different nitrogenous fertilisers in grassland experiments at Gisselas and Sörbyn (*Sweden*) 322
  Comparative experiments relative to the fertiliser value of phosphorite meal, superphosphate and basic slag 217
  Different kinds of barley and oats in five years' experiments on sphagnum peat soil at Flahult, Sweden (*Sweden*) 216
  Effectiveness of cultural treatments in control of weeds 321
  Effect of calcium cyanamide on the soil microflora with special reference to certain plant parasites 321
  Effect of potash fertilisers in increasing potato yields (*Germany*) . . 322
  Experimental work on manurial value of synthetic urea 321
  Fertiliser experiments with oats covering a period of two years . . 217
  Fertiliser value of some concentrated materials, particularly urea and guanidine and their nitrates and phosphates 216

Soils—*continued.*
  Formamide and ammonium formate as nitrogen sources for plants . . 322
  Formamide as a nitrogenous fertiliser (*U.S.A.*) 322
  Green manure fertiliser study on Norfolk sand 216
  Increasing amounts of potassium as 40% potash fertiliser and as cement potash (*Sweden*) 322
  Influence of organic matter on nitrate accumulation and the base exchange capacity of Dickinson fine sandy loam (*U.S.A.*) 216
  Influence of potash deficiency on the development of sugar beet (*Germany*) 322
  Influence of soil management on some physical properties of a soil (*U.S.A.*) 216
  Influence of types of rocks on the plant food content of natural soils (*Finland*) 217
  Influence of wart disease on the metabolic processes involving magnesium in the potato tuber (*Germany*) 216
  Manganese in New Jersey soils 217
  Phosphate status of Mauritius soils 321
  Plant food advisory Council of New South Wales—First report . . 321
  Rate of decomposition of various plant materials in soils (*U.S.A.*) . 216
  Relationship as between the phosphorus content in the soil and the reaction conditions 217
  Response of grasses and clover to treatment on acid upland soils, and the effect of herbage plants on reaction of acidic soils, Part 3 . . . 321
  Response of plants to boron, copper and manganese (*U.S.A.*) . . . 216
  Soil fertility, cleaning dirty land to produce 41
  Weed seed population of arable soil, III—The re-establishment of weed species after reduction by fallowing 217

State intervention in agriculture 331

Stirling, John, N.D.A., N.D.D., C.D.A.D.(Hons.): Flax-growing in Scotland 150

Struthers, J. P., B.Sc., N.D.A., and M'Candlish, A. C., B.Sc., Ph.D.: Keeping the proven sire 287

Studentships for research in animal health 91, 386

Sweden:
  Comparison between the effects of different nitrogenous fertilisers in grassland experiments at Gisselas and Sörbyn 322
  Different kinds of barley and oats in five years' experiments on sphagnum peat soil at Flahult 216
  Increasing amounts of potassium as 40% potash fertiliser and as cement potash 322

Tervet, I. W., B.Sc., and Braid, K. W., M.A., B.Sc.: Certain botanical aspects of dying-out of heather 365

Tuberculosis (Attested Herds) Scheme 87, 204, 307

Unemployment in agriculture 207, 312, 393

United States:
  Alfalfa-molasses silage vs. alfalfa hay as a roughage for lactating dairy cows 320
  Availability of phosphate rocks in soils of varying degrees of acidity . 322
  Beef and dual purpose cattle breeding 102
  Breeding for resistance to late blight in the potato 212
  Churn cleaning methods 215

United States—*continued.*
  Cleaning dairy equipment 215
  Comparison of management methods for chicks, layers and breeding hens 318
  Effect of feeds on quality and palatability of lamb 319
  Effect of size and type of ewe on efficiency of production 106
  Experiment in chopping alfalfa hay at time of storage 320
  Formamide as a nitrogenous fertiliser 322
  Improving horses and mules 103
  Inbreeding in the white Leghorn 214
  Influence of organic matter on nitrate accumulation and the base exchange capacity of Dickinson fine sandy loam 216
  Influence of soil management on some physical properties of a soil 216
  Lethal nature of flightlessness in the fowl 318
  Locust meal as a poultry feed 318
  Mortality in chick embryos 214
  New lethal factor in the horse 318
  Position of the chick at hatching 214
  Problem of causes of blackening in cooked potatoes 316
  Problem of potato breeding 101
  Producing better dairy cattle 103
  Quantities of grass that dairy cows will graze 105
  Rate of decomposition of various plant materials in soils 216
  Response of plants to boron, copper and manganese 216
  Soft pork 103
  Superior breeding stock in poultry 103
  Swine—Some current breeding problems 103
  Tested sires and dams of the Jersey breed 319
  Trek of the golden fleece 213
  Variations in the vitamin C content of milk 320

U.S.S.R.:
  Aberdeen-Angus under conditions in U.S.S.R. 213
  Effect of nutrition on sexual function 104

Variation in retail milk prices between different areas 228

Vick, J. O. C., A.R.C.S., B.Sc., D.I.C., A.Inst.P., and Howells, Dudley V., Agric. Dip. (U.C.W.): Some recent work on the preservation of perishable foodstuffs 135

Watson, Professor J. A. S.: Increased meat production 10

Whelan, L. A., M.Sc., Ph.D.: The effects of lime on the soil 258

Winter census of cattle, sheep and pigs 208

Wintering of ewe hoggs 166

Wireless talks on agriculture 87, 392

Witney, D., B.Com.: Flax-growing in Scotland: costs and returns 157

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